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THESIS

INVESTIGATION OF IPPD: A CASE STUDY OF THE MARINE CORPS AAAV

by

Travis L. Sutton

March 1998

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Both Industry and Government Executives agree that collocation is a successful method of organizing Integrated Product Teams (IPTs) for Integrated Product and Process Development (IPPD). While some research has addressed benefits and challenges of implementing collocated-IPTs within Government and Industry organizations, there is a lack of clarity on specific benefits and challenges of collocated-IPTs in a team-based organization. This study examines full-time members' views of collocation regarding the Marine Corps' Advanced Amphibious Assault Vehicle's (AAAV's) program. The AAAV program is the first major defense acquisition program (MDAP) in the Department of Defense (DOD) to collocate all appropriate full-time employees representing the Government Civilian, General Dynamics--the Contractor, subcontractors, and Marines--the customer. Research methods used to gather data consisted of phone and face-to-face interviews, and a survey. The interviews solicited elaboration on two main issues: specific examples of benefits and challenges of collocation. The survey identified the impact of collocation on specific management processes. Findings show collocation as having a positive impact with strongest areas including: "identifying potential problems," "liaison with customer," and "reducing project cycle time." The results suggest lessons to expand the benefits of collocation on AAAV's performance, and offers a benchmark for other programs implementing collocated-IPTs.

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INVESTIGATION OF IPPD: A CASE STUDY OF THE MARINE CORPS AAAV

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Submitted in partial fulfillment of the
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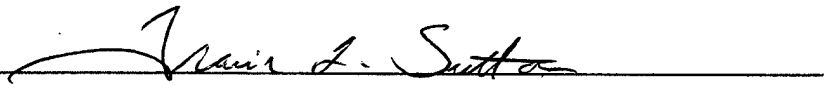
Author: 

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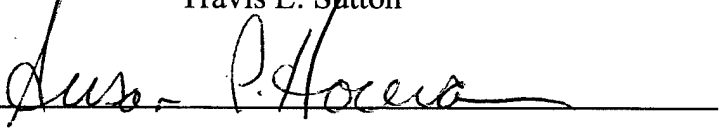
Approved by: 

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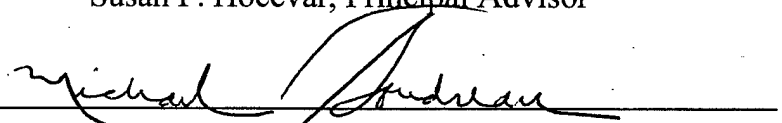

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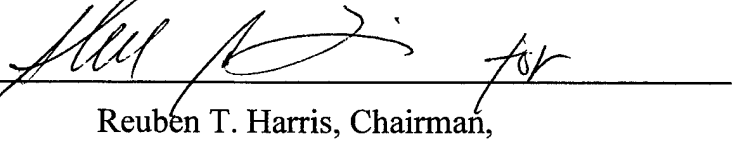

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ABSTRACT

Both Industry and Government Executives agree that collocation is a successful method of organizing Integrated Product Teams (IPTs) for Integrated Product and Process Development (IPPD). While some research has addressed benefits and challenges of implementing collocated-IPTs within Government and Industry organizations, there is a lack of clarity on specific benefits and challenges of collocated-IPTs in a team-based organization. This study examines full-time members' views of collocation regarding the Marine Corps' Advanced Amphibious Assault Vehicle's (AAAV's) program. The AAAV program is the first major defense acquisition program (MDAP) in the Department of Defense (DOD) to collocate all appropriate full-time employees representing the Government Civilian, General Dynamics--the Contractor, subcontractors, and Marines--the customer. Research methods used to gather data consisted of phone and face-to-face interviews, and a survey. The interviews solicited elaboration on two main issues: specific examples of benefits and challenges of collocation. The survey identified the impact of collocation on specific management processes. Findings show collocation as having a positive impact with strongest areas including: "identifying potential problems," "liaison with customer," and "reducing project cycle time." The results suggest lessons to expand the benefits of collocation on AAAV's performance, and offers a benchmark for other programs implementing collocated-IPTs.

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I. INTRODUCTION

A. PURPOSE

This thesis examines the implementation of collocated-Integrated Product Teams (IPTs) at the Marine Corps' Advanced Amphibious Assault Vehicle's (AAAV's) program and analyzes the benefits and disadvantages from the perspectives of the USMC Program Management Office and General Dynamics, the Contractor. The results establish a baseline for evaluating the effects of collocation. They also offer a benchmark for other programs as they initiate collocation. Finally, the research results also suggest recommendations to expand the benefits of collocation on AAAV program performance.

B. BACKGROUND

Within the Department of Defense (DoD), Integrated Product Teams (IPTs) are one of the fundamental mechanisms for achieving Integrated Product and Process Development (IPPD) in defense acquisition programs. IPPD is a management technique that integrates all acquisition activities starting with requirements definition through production, fielding/deployment and operational support in order to optimize the design, manufacturing, business, and supportability processes. (SECDEF MEMO, 1995, p. 1)

An IPT is a group of people formed for the specific purpose of delivering a product or developing a process or policy. (SECDEF MEMO, 1995, p. 1) The IPT serves to thoroughly coordinate activities within programs and to reduce the overall cost of doing business. Integrated Product Teams are being implemented both in defense and industry by integrating suppliers, customers, and functional "stovepipes" within organizations.

While it is recognized that large acquisition programs with geographically dispersed organizations cannot easily collocate everyone, both industry and government agree that collocation simplifies management, communication, and coordination. Notionally, every effort should be made to collocate team members where feasible. (Crow, 1995, p. 1) Collocation is defined as the physical proximity (i.e., next door, next floor, or nearby buildings) of the various individuals, teams, functional areas, and organizational subunits involved in the development of a particular product or process. (Rafii, 1995, p. 78)

The United States Marine Corps is in the process of developing their next generation of Advanced Amphibious Assault Vehicles (AAAVs) as the modern replacement for the existing Amphibious Assault Vehicle (AAV7A1) model. The AAAV's mission is to: (1) provide high speed transportation of embarked Marine Infantry from ships located beyond the horizon, to inland objectives; and (2) provide armor protected land mobility and direct fire support during combat operations ashore.

The Advanced Amphibious Assault Vehicle is the first major defense acquisition program in DOD to collocate all appropriate full-time employees. Since December 1996, approximately 250 people--from General Dynamics, Civilian and uniformed Marine Corps personnel, and subcontractors--have been working in teams at a 62,000 square feet facility in Woodbridge, Virginia. Currently, the AAAV program is in Phase I of the Acquisition Process, Program Definition and Risk Reduction (PDRR).

C. SCOPE, LIMITATIONS AND ASSUMPTIONS

The scope of the thesis is limited to a single case study that explores the views of both the Program Management Office and Contractor in using collocated-IPPD/IPT for AAAV. The concern with single site case studies is the potentially

limited ability to generalize the findings. However, this study gathers data from multiple IPTs thus increasing reliability and likelihood that results might reflect lessons that can be applied to other IPTs and programs.

The Advanced Amphibious Assault Vehicle community has been assembling collocated-IPT (Government and contractor personnel) over the past sixteen months. This limited timeframe might constrain evidence of impact; however, the study will provide an early baseline. This research assumes that the reader has a general knowledge of, or is familiar with, the Integrated Product and Process Development.

A key assumption about the value of collocated-IPTs is that the opportunity for direct interaction among team members, (e.g., decision making, conflict resolution, and process management) will positively impact team performance.

D. RESEARCH QUESTION

The primary research question is: What is the perceived impact of collocation of IPTs on the success of the Marine Corps AAAV program?

E. OBJECTIVES

This study seeks to extend the body of knowledge on IPPD by investigating full-time members' views of the impact of collocation on IPPD. In particular, this study investigates three issues concerning the use of collocated-IPTs. The first objective is to learn from the full-time members, the benefits and disadvantages of being physically collocated. The second objective is to discover the impact of collocation on specific team processes, such as defining work responsibilities and developing skills. The third objective is to uncover the challenges and impediments, of implementing collocated-IPTs from the perspectives of full-time members.

F. SIGNIFICANCE OF THE STUDY

A memorandum from the Assistant Secretary of the Navy for Research, Development & Acquisition and Research Development (ASN (RD&A)), specifies Navy policy for geographic collocation with the prime contractor for management of major programs during critical program phases to the maximum extent possible. (ASN (RD&A), 1996) .This memo also encourages other than ACAT I programs to consider the potential benefits of collocation. Determining the impact that collocation has on IPTs, within a major defense acquisition program, is the purpose of this study. It is important for managers from Government and industry to understand what effects this change may have on IPTs, because teams' performance are indicators of future organizational performance and effectiveness.

G. THESIS OVERVIEW

The remainder of this thesis is comprised as follows. Chapter II is a literature review which (1) provides a summary of related research on Integrated Product and Process Development (IPPD) for background, and (2) discusses organization theory related to team effectiveness. Chapter III includes details of the research design and methodology including the survey instrument and interview questions. Chapter IV presents background and the current organizational structure of the AAAV Program. Chapter IV also analyzes the workers' responses from both survey and interview questions developed in chapter III. Finally, this thesis presents conclusions and recommendations for the AAAV program and major defense acquisition programs' applications, as well as recommendations for future research (Chapter V).

II. LITERATURE REVIEW

A. INTRODUCTION

This chapter first addresses the development of Integrated Product and Process Development (IPPD) and Integrated Product Teams (IPTs), and provides basic concepts and principles within a Program-level Integrated Product Team (PIPT). Second, this chapter presents related research and theory on team based organizations and effectiveness, focusing on IPTs in a collocated environment. Understanding the background, concepts, and principles of IPPD and IPTs are considered to be relevant to any team-based organization.

B. DEVELOPMENT OF IPPD

As major defense acquisition programs (MDAPs) have become more complex and expensive, the Department of Defense (DoD) has explored a variety of ways to reduce costs, decrease the acquisition cycle, and enhance performance of acquired systems. To achieve these factors, then Secretary of Defense William Perry, in 1995, directed the use of Integrated Product and Process Development/ Integrated Product Teams (IPPD/IPTs) in the defense acquisition process. (SECDEF MEMO, 1995)

Integrated Product and Process Development (IPPD) recognizes the need to align multiple incentives toward building a quality product for the user. Department Of Defense Directive 5000.2-R mandates: "Program Managers (PMs) and other acquisition managers shall apply the concept of IPPD throughout the acquisition process to the maximum extent practicable." (DoD 5000.2-R, Paragraph 1.6)

Unlike traditional, hierarchical management structures that separate functional responsibilities, IPPD integrates all functional expertise into Integrated

Product Teams (IPTs), which are multi-functional and formed for the specific purpose of delivering a product to the user's satisfaction. IPPD is defined as:

> A management technique that integrates all acquisition activities starting with requirements definition through production, fielding/deployment and operational support in order to optimize the design, manufacturing, business, and supportability processes. (Lopez, 1994, p. 6)

IPPD gets its roots from Concurrent Engineering (CE) and Systems Engineering (SE) that have been used in U.S. industries since the 1980's to enhance the product development process. (Lake, 1991) Each of these approaches is defined as follows:

> [In CE], a product design and its manufacturing process are developed simultaneously, cross-functional groups are used to accomplish integration, and the voice of the customer is included in the product development process. (Smith, 1997, p. 67) CE involves multiple functions in decision-making on product design so that downstream issues such as manufacturability, marketability, serviceability, and total life cycle problems are anticipated at early steps. (Hull, Collins, and Liker, 1996, p. 133)

> Systems engineering (SE) is a process which transforms an operational need into a description of system parameters, such as cost, schedule and performance, and integrates those parameters to optimize the overall system effectiveness. A system life cycle begins with the user's needs and the capability requirements needed to satisfy mission objectives. (EIA IS-632, pp. 49-50)

Both CE and SE concepts were adopted from Japanese firms that particularly developed skills at integrating both the human and technical side of operations to be both productive and inventive following World War II. (Hull, Collins, and Liker, 1996, p. 133)

IPPD expands both CE and SE utilizing a systematic approach to the integrated, concurrent development of a product and its associated manufacturing

and sustainment processes to satisfy customer needs. It differs from CE and SE in that interrelated tasks are accomplished simultaneously instead of sequentially. (Moore, 1996, p. 19)

C. ORGANIZING FOR IPPD

1. Tenets

IPPD provides a formal structure and set of ten tenets used in diverse segments of industry. The application of these ten tenets ensures the program is operating under IPPD philosophy. Explanation of these tenets listed below are cited in Appendix A:

- Customer focus
- Concurrent development of product and process
- Early and continuous life-cycle planning
- Maximize flexibility for optimization and use of contractor-unique approaches
- Encourage robust design and improved process capability
- Event-driven scheduling
- Multi-disciplinary teamwork (IPTs)
- Empowerment
- Seamless management tools
- Proactive identification and management of risk

2. IPT as an Enabler of IPPD

An Integrated Product Team (IPT) is a key tenet of IPPD. It is composed of representatives from all appropriate functional disciplines (e.g., program management, engineering, manufacturing, test, logistics, financial management, procurement, and contract administration) including users and suppliers, working together with a team leader to build successful and balanced programs, identify and resolve issues, and make sound and timely decisions (Navy AR-Homepage,

1997, Internet). Integrated Product Teams (IPTs) can be effective for larger or complex projects and for developing processes or policies (DiTrapani, 1996, p. 2).

D. IPTS IN THE EXECUTION PROCESS

The execution of a Major Defense Acquisition Program (MDAP) occurs at the Program-level IPT (PIPT). A PIPT typically includes the user, program management personnel, along with contractors and subcontractors. A description of these key "stakeholders" is provided below.

The user community's contribution to a successful IPPD effort and program is at the initial stage of a development process to provide guidance for a realistic, stable statement of mission needs. The user provides valuable input in cost/performance trade-offs throughout the life cycle of the program.

DoD provides many functions and activities through program management personnel support not directly engaged in the technical aspects of product and process design. For example, management personnel assist the PM in developing a well-constructed request for proposal (RFP) and a sound acquisition strategy. Both are important to achieve an successful acquisition. The Defense Contract Management Command (DCMC) provides useful manufacturing cost information necessary to make cost/performance trade-offs. A legal staff can also provide expertise in areas such as patents or product liability of commercial products used in the system under acquisition, data rights, and the role of DoD and industry personnel in IPTs.

The Contractor is responsible for designing, developing, and delivering the product or service to the customer. Being on PIPTs allows the Contractor to organize for specific areas or issues; focusing primarily on resolving technical problems, providing guidance and counsel on all technical issues, and assessing the feasibility of applying new technologies into the program. The Contractor

accomplishes these areas or issues throughout use of their IPTs. After contract award, Government members can serve on the industry IPTs and vice versa.

Subcontractor(s) can be highly innovative and produce high quality, technologically sophisticated components. Being on PIPTs allows subcontractors to stay current on important issues, such as contract management and risk management, that require a high level of communication and control between the subcontractor(s) and the contractor.

E. PROGRAM LEVEL-IPT (PIPT) ORGANIZATION

A prototype Program-Level Integrated Product Team (PIPT) structure is presented in Figure 2.1. It illustrates four levels with the highest level being the Executive Management Team (EMT). Usually, the Executive Manager (EM) is the Program Manager (PM). However, under teaming arrangements made between the Government and the Contractor, an executive management team (EMT), may co-lead. Hence, the EM (or EMT) establishes a PIPT for specific areas or issues.

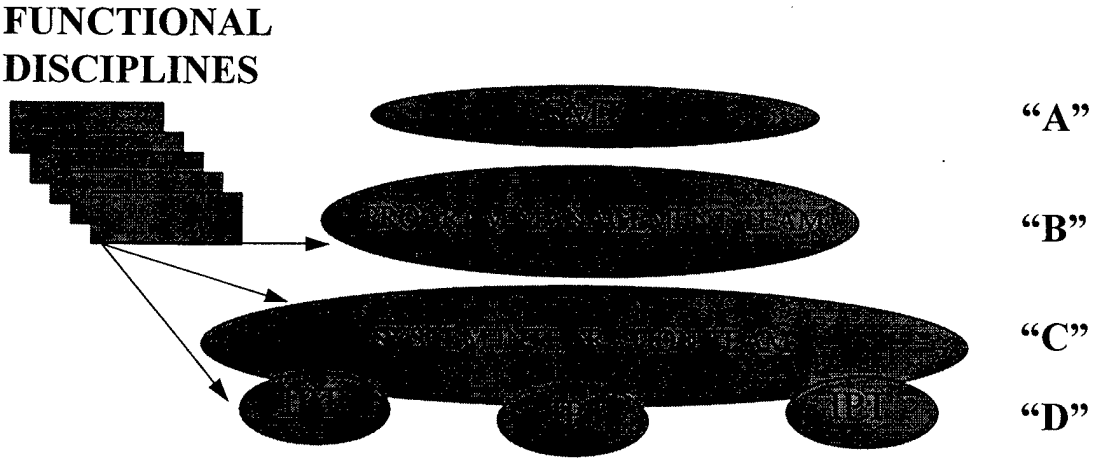


Figure 2.1. Program-Level Integrated Product Team (PIPT)

Source: Developed by author.

Multiple team levels of IPTs may be required due to program size or product complexity. Hence, the risk associated with a product, such as high cost, technological complexity, or compressed delivery schedule, will determine how many levels of IPTs are required.

The lower level teams (Levels C and D) manage elements of the program's resources and risk, integrate Government and contractor efforts, and report program status and issues. These teams are created as necessary to execute and track program plans, usually in agreement with the Work Breakdown Structure (WBS). Lower level Teams may consist of representatives from DoD, the user, and industry. IPTs may be created in a horizontal or vertical relationship with other IPTs. Normally, lower level IPT leaders are members of the intermediate Program level IPT which provides coordination of the work effort.

As seen in Figure 2.1, a typical PIPT consists of the following team levels: a program management team, a system integration team, and IPTs. This notional structure allows for the creation of an integrated management plan using resources (tools, teams, processes) as part of a disciplined approach. This framework, established by the executive manager(s), can then outline responsibilities of constituent teams. A description of each team is discussed below.

At the top of the organization, the Executive Management Team (EMT) provides overall strategic direction and manages the capabilities and performance of IPTs. A Program Management Team (PMT) is responsible for coordinating the management of a number of IPTs that are interdependent in the accomplishment of processes or products. In addition, the PMT gives direction and provides management of the overall design and performance of the program for which it is responsible. Hence, its shared goal is the overall performance of the PIPT. (Mohrman, Cohen, and Mohrman, 1995, p. 41)

A System Integrating Team (SIT) is established to make sure the work across various elements of the organization fits together. These include IPTs that

link together the work of two or more interdependent IPTs, and teams that cut across various parts of the organization that share a focus, perhaps on a particular user, product, or technology. A SIT's objective is to provide direction and coordinate efforts toward the shared focus of IPTs. The interdependence among the IPTs being integrated often stems from the fact that they are participants in a common organizational process in which they play different but related parts. (Mohrman, Cohen, and Mohrman, 1995, p. 41)

IPTs provide a mechanism to facilitate early involvement of the key functions that are involved in the design, production and support of a product. This early involvement is intended to result in the design and production of a product on schedule and within budget that is lower in cost, higher in quality, and more reliable and supportable. A typical IPT consists of people from all disciplines (e.g., designer, product service and support, product cost analyst, procurement, test engineer, quality engineer, and manufacturing engineer) working together with a team leader that can positively impact the development of a product or service.

1. Principles and Characteristics of IPTs

Dr. Perry (1995) provided key tenets of IPPD (see Appendix A). Other DoD guidance describes principles or characteristics of Integrated Product Teams (IPTs). These IPT principles and characteristics are consistent with Dr. Perry's guidance.

There is no perfect framework that will fit each organization; however, understanding the key principles and characteristics of an IPT, within the PIPT, will help in building an organization to gain the most benefits (Lopez, 1994, p. 9). There are six key principles in operating an IPT (DoD 5000.1, p. 7):

- Open discussions with no secrets
- Qualified, empowered team members

- Consistent, success oriented, proactive participation
- Continuous 'up the line' communication
- Reasoned disagreement
- Issues raised and resolved early

The key characteristics of an IPT are:

- Team is set up to produce a specific product or service
- Multi-disciplinary-all team members working together towards a common goal
- Members have mutual, as well as individual accountability
- Empowered, within specific product or service goals to make decisions
- Planned integration among teams toward system goal
- Teams may be created in a horizontal or vertical relationship with other teams (Lopez, 1994, p. 9)

2. IPTs and Collocation

There is a general consensus among industry and Government that collocation can be simply defined as the physical proximity (i.e., next door, next floor, or nearby buildings) of the various individuals, teams, functional areas, and organizational subunits involved in the development of a particular product or process. (Rafii, 1995, p. 78)

DiTrapani and Geither's (1996) study of IPTs stressed the collocation of team members to the maximum extent possible, due to large programs with geographically dispersed industry and Government managers. They pointed out that collocation of all full-time members of an IPT was probably the single most effective way to improve communication, break down organizational barriers, and streamline and accelerate the decision making process. The study also indicated that collocation has the most benefit during the early stages of design and

development, when there are more coordination requirements, and communications are more complex and frequent. (DiTrapani and Geither, 1996)

According to industry and Government, establishing IPTs in a collocated environment may require more resources (i.e., capital, costs, labor, training, etc.) early in the development phase. But there is a consensus that the return will result in:

- Superior designs
- Reduced resources over the life cycle of development production and support through reduced design/build/test iterations
- Less efforts to correct initial design deficiencies through engineering changes
- Less effort to manufacture, test, fix, and support the product

Hence, the IPT approach in a collocated environment will lead to greater commitment to the design and will result in a smoother transition to production. (Crow, 1995, p. 1)

Hull, Collins, and Liker (1996) conducted a quantitative study to identify the organizational characteristics (e.g., organization design, information technology, and process design controls) that are more likely to reduce time and cost towards product development. They concluded that organic practices like cross-functional teaming, collocation, team rewards, and early, simultaneous influence in design decisions are aggressive ways of ensuring every function in the process from suppliers to customers, to be more closely integrated. Moreover, in-process design controls helped diverse functional specialists to work together by providing common design parameters that focus everyone on meeting user requirements. Finally, the extensive use of computer-aided, information intensive, technologies facilitated interdepartmental communication and allowed product design teams to embed design controls in software applications.

However, according to Raffii (1995), "collocation, at best, is but one factor in an array of approaches that can help achieve effective integration...and that Managers should seriously consider alternative means of communication and integration before going through the expense and trouble of collocating team members" (Raffii, 1995, p. 78).

3. Stages to Collocation

Kenneth Crow (1995) depicts three stages to collocation. He suggests that departmental collocation (Stage 1) provide for a greater opportunity for functional departments, such as engineering, production and manufacturing, to interact with personnel from other functional departments. This also holds true for collocated-IPTs (Stage 2). In both stages, individuals have an opportunity to develop a close working relationship that improves overall team dynamics, as they work together on a day-to-day basis in close proximity. Being collocated:

- Enhances the frequency and quality of communication,
- Provides greater opportunity for feedback and discussion,
- Provides better coordination of team activities, and
- Allows team members to respond more rapidly to issues and initiate process tasks more quickly.
- Decreases infrastructure requirements such as technical networks, document distribution, secretarial support.

Virtual collocation (Stage 3) allows dispersed team members or personnel, who cannot physically collocate, to achieve communication through technology (e.g., electronic mail, telephone, video conferencing, and design automation networks). Crow argues that even with these communication and system tools, there is still value in the face-to-face contact between team members, and an investment should be made in physically bringing team members together for a period of time. Hence, collocation of IPTs will allow members to develop a

relationship and establish a shared purpose that is otherwise difficult to accomplish across a distance. (Crow, 1995, p. 3)

F. MAKING THE TRANSITION TO TEAM COLLOCATION

This section discusses team skills, management and self-management functions, and leadership roles performed by upper managers (i.e., IPT leaders, EMT) and members. Mohrman, Cohen, and Mohrman (1995) encourage upper management to empower and involve teams in: (1) determining how various leadership tasks will be performed, (2) providing mechanisms for lateral IPT team integration, (3) creating management roles, (4) coordination of IPTs with upper management, and (5) making large scope decisions. The following discussion draws on the recommendations of Mohrman, Cohen, and Mohrman (1995).

1. Team Skills

Team members must have or develop the right management skills. Some of the critical skills required for successful teaming include: (1) technical or functional competence; (2) cross training; (3) interpersonal and conflict resolution; (4) decision-making; and (5) leadership.

a. Technical or Functional Competence

The team's collective knowledge must be sufficient to reach the desired objectives. Hence, the team members must have the technical skills and knowledge that will allow each to represent his or her particular functional area and contribute his or her expertise to the team's goals and objectives. Initially, team members may not have all the skills they need to support the team's objectives when they are first assigned to the team. Therefore, education and training processes must be ongoing where members continuously learn from their technical mentors, formal training, informal training, experience, and from each other. (Mohrman, Cohen, & Mohrman, 1995)

b. Cross Training

The more team members know about other specialty areas represented on the IPT, the better the chances for effective communications among that team. Also, cross training provides flexibility, giving members the capacity to adjust to balancing the workload. Upper management can ensure those opportunities for learning across disciplines by adopting reward systems (e.g., monetary or non-monetary) that encourage learning of new skills. Implementing skill-based incentives would encourage members. (Mohrman, Cohen, & Mohrman, 1995)

c. Interpersonal and Conflict Resolution Skills

Common understanding and purpose cannot arise without effective communication and constructive conflict, which in turn depend on interpersonal skills. These include risk taking, helpful criticism, objectivity, and active listening, giving the benefit of the doubt, and recognizing the interests and achievements of others. Without clear goals and objectives, conflict resolution is not practicable. (Mohrman, Cohen, and Mohrman, 1995)

d. Decision-Making Skills

Teams must be able to identify the problems and opportunities they face, evaluate the options they have for moving forward, and then make necessary trade-offs and decisions about how to proceed. This systemic decision making process can be tailored to the job and within the team, but the IPT must be sure to take the time to conduct training and to orient new members to the process. It is important that the decision making process adopted by the team be acceptable to all team members. If not, resistance will hinder the process and will be counterproductive. (Mohrman, Cohen, & Mohrman, 1995)

e. Learning Skills

Team members must be willing to develop and expand interpersonal skills and conflict resolution skills, and they must stay current in appropriate functional areas of expertise. Moreover, members may be required to attend formal training in their disciplines outside of the team environment. Team members must also be open to learning something about the other disciplines on their team. The more each member knows about the disciplines involved with his or her team, the better the team will communicate, interact, and solve problems. (Mohrman, Cohen, & Mohrman, 1995)

f. Leadership Skills

Team members must be ready to assume various leadership roles, such as team leader, technical mentor, trainer, system integrator, and liaison. In order to perform such roles, members must develop the skills discussed above that will allow them to influence others, manage meetings, and communicate effectively, toward solving problems and resolving issues. (Mohrman, Cohen, & Mohrman, 1995)

2. Management and Self-Management Functions

The EMT is responsible for tightening the association between the work of IPTs and the whole system. Some of these responsibilities include:

- Aligning the team's systematic measures and processes
- Supporting the team in adopting measures and processes
- Supporting the team in adopting and maintaining high standards
- Ensuring all team members understand performance expectations
- Ensuring team members get required training
- Ensuring that IPTs are aware of the organizational policies and charters.

IPT leaders keep their teams focused. A high quality effective team leader is a team player with good leadership attributes who has the ability to guide the team's operation. The leader should have good communication skills, a broad knowledge foundation, and be familiar with various functional aspects that affect the performance of the team product. (Lopez, 1994)

IPT members can take on responsibilities for management functions, traditionally performed by upper management. These functions consist of task management, boundary management, technical leadership, and performance management functions. (Mohrman, Cohen, and Mohrman, 1995):

a. Task Management

IPTs perform task management activities, such as assignment of member work responsibilities, balancing workload, identifying project objectives, and establishing cohesiveness on project objectives.

b. Boundary Management

IPTs may be empowered to handle certain boundary management functions, such as liaison with the user, subcontractors, other IPTs, and upper management. For example, the voice of the user is more directly heard as IPTs develop liaison with the user, to receive on-line information about user requirements from shared data bases that connect IPTs to the user and subcontractor organizations. IPT leaders and the EMT ensure that work is integrated across IPTs and responds to the requirements of the user. In particular, upper management involvement lies in providing management approval of project objectives, work-plans, and changes to program work-plans. Coordinating interactions ensures that there are mutually agreed upon processes governing the liaisons and monitoring and improving interface management.

c. Team Leadership

IPT members ensure that technical knowledge and skills continue to be updated, and may provide for the technical mentoring, coaching, and cross-training of other members. Upper management makes sure that work-opportunities and career paths offer technical development opportunities.

d. Performance Management

IPT members share responsibility for performance management, including development of team and individual goals, reviewing team performance, and handling disciplinary problems. Mohrman, Cohen and Mohrman (1995) points out that these processes may not be satisfactorily directed if teams lack adequate skills, involvement of skilled facilitators, and training to apply information surfacing, conflict resolution, and consensus-building processes.

G. SUMMARY

This chapter first described the development and basic concepts of Integrated Product and Process Development (IPPD); IPPD includes business practices, as well as technical disciplines. The benefit of IPPD is an increase in user satisfaction due to delivery of a higher quality product in a more timely and efficient manner, and at an affordable cost. Integrated Product Teams (IPTs) are means to accomplishing IPPD. By getting people from all appropriate disciplines involved early, this approach will result in a more complete understanding of all the user requirements; a broader, more balanced discussion of issues and alternatives; and a consensus approach to designing both the product and its processes. The IPT concept is intended to promote open discussion and innovative thinking resulting in superior products, more efficient processes and, ultimately, a more satisfied user.

Second, related research and theory provided support of collocation in the IPPD/IPT process. Collocation provides the physical accesses and improves communication and coordination to achieve the parallel design of products and their processes. A key assumption about the value of collocated-IPT members is that the opportunity for regular interaction among team members, and working together on processes, will positively impact team performance. More specifically, collocated teams should do better with decision making, conflict resolution, evaluation and rewards, job scheduling, and managing relationships with other IPTs. As personnel have an opportunity to interact and develop relationships, issues and questions can more easily be resolved.

Finally, this chapter addressed making the transition to team collocation. A well-managed and properly structured team-based organization (TBO) will provide Executive Manager(s) better insight with less oversight. However, a successful TBO will require a significant investment by the Executive Managers in time and resources. Not only must members learn new interpersonal skills, they must find innovative ways to retain core skills and competencies which could deteriorate as they spend less time with their functional groups and more time with IPTs. The TBO must be committed to culture change from a traditionally managed independent organization to a team based entity characterized by empowerment, free and open communications, shared purpose, ownership, commitment, continuous self-assessment, and process improvement.

III. METHODOLOGY

A. INTRODUCTION

This chapter presents the methodology used to investigate employees' views on the impact of collocation on Integrated Product and Process Development (IPPD) pertaining to the Advanced Amphibious Assault Vehicle's (AAAV's) program. The research method is defined by the three subsidiary research objectives concerning the use of collocated-Integrated Product Teams (IPTs). The first objective was to learn from the employees, the benefits and disadvantages of being physically collocated. The second objective was to discover the impact of collocation on specific team processes. Finally, the third objective was to uncover the challenges and impediments, of implementing collocated-IPTs from the views of the employees.

B. RESEARCH STRATEGY AND IMPLEMENTATION

The research methods used to answer the primary and subsidiary objectives consisted of conducting interviews both face-to-face and phone, and administering a survey. Both methods are discussed below.

1. Telephone and Face-To-Face Interviews

Telephone and face-to-face interviews were used to collect current, non-historical data. The researcher created two separate lists of interview questions--one for executive management, and the other for team leaders and members. The questions were designed to solicit responses that would answer the primary and subsidiary objectives presented in the introduction of this chapter. All interviews were recorded on a mini-tape recorder, then transcribed and compiled into cumulative response lists that allowed the data to be categorized and analyzed.

How Interviews Were Conducted

For all telephone and face-to-face interviews, the list of appropriate questions was sent to the interviewees well in advance of the scheduled interview. A hard copy of the questions was faxed to the two executive managers for approval, who in turn distributed the interview questions to others in the interview sample. The researcher requested, and in all cases received, permission to tape record the interviews. Prior to conducting the face-to-face interviews, the interviewees were informed of the purpose of the interview and that no individual would be specifically identified in the thesis. Each session lasted between 30 and 60 minutes.

The researcher maintained a separate response form for each interview, which included all of the administrative information (e.g., name, telephone number, and e-mail address) needed to reestablish contact with the respondent if necessary. All completed response forms were indexed and cross-referenced to the appropriate mini-cassette tape used during the interview. The following interview questions were used in both the telephone and face-to-face interviews.

Interview Questions for Executive Managers

- What were your expectations of collocated-IPTs during their establishment (pros/cons)? If you can, please quantify the benefits (or disadvantages) that you have experienced (during their use).
- What are your biggest issues/concerns with collocated-IPTs? How is collocation not meeting its potential or what new problems result from collocation? If possible, quantify the evidence of problematic results.
- What would you change in the current collocated-IPT structure or process to improve it?

Interview Questions for Team Leaders and Members

- What was the motivation to pursue collocation?
- What were the anticipated benefits? (i.e., specifics) In what specific ways have these benefits been realized to date? Evidence?
- How has collocation impacted the following:
  - Trust
  - Resolving Conflict
  - Communication
  - Leadership
  - Managing Change
  - Group Dynamics
  - Teamwork
  - Reward and Recognition
  - Customer Focus
- Are there some expectations that have been more difficult to achieve? What are they and why? (i.e., specifics)

2. Site Visit

The site visit lasted four working days and included face-to-face interviews with the Direct Reporting Program Manager, the Vice-President of General Dynamics, six employees from the Government, and four workers from General Dynamics. The selected group of twelve represents all four IPT-levels (i.e., "A" through "D"). Also, six Government employees were comprised of four IPT leaders and two IPT members; of the four employees from General Dynamics, three were IPT leaders and one was an IPT member. In all cases, IPT leaders also serve as team members of an IPT-level above them.

3. Procedures Used for Analyzing the Findings

The data recording procedures used for this research were note taking and mini-cassette recording. Once all interviews were completed, the researcher transcribed the data captured on the tape recordings into written text, combining those data with the hand written back-up notes. Response themes were then consolidated into a master interview response sheet for the appropriate type of

interview (i.e., phone or face-to-face). The master interview response sheets further facilitated sorting and analysis of the data.

The second method used to collect data was a survey. Surveys were distributed to 34 individuals representing the Contractor/subcontractor, and 65 individuals representing the Government. Of the 99 sampled, 58 participated for a response rate of approximately 59%. Once the data was tabulated in raw form, descriptive statistics (mean, standard deviation, and significant t-test) were calculated for each question, and tables were prepared to present the results.

a. Research Instrument Design

There was no implementation guide found in related research as the standard against which the AAAV program could be evaluated. Therefore, a baseline mechanism for evaluating the effects of collocation was established by the researcher.

Mohrman, Cohen, and Mohrman's (1995) book, "Designing Team-Based Organizations", and the Center for Naval Analyses (1996) study, "Getting the Most Out of Integrated Product Teams (IPTs)" were selected from literature review to define the relevant variables for evaluating the impact of collocation for the AAAV program. The survey designed based on this material consisted of three open-ended statements and 45 closed-ended statements. The three open-ended statements were the same as those used in the phone interviews. To develop the survey, the researcher identified key variables, which consisted of: (1) task management, (2) boundary management, (3) team leadership, (4) performance management, and (5) management outputs and dynamics management. Within these variables, statements were designed to rate the impact that collocation has had on the IPTs' ability to accomplish processes; this included decision making, conflict resolution, evaluation and rewards, job scheduling, and managing relationships with other IPTs.

The survey used a Likert type response choice. Two sample questions are presented here. The complete survey can be found in Appendix B.

RATE THE IMPACT THAT COLLOCATION HAS ON YOUR TEAM'S ABILITY TO ACCOMPLISH THE FOLLOWING:

	large negative impact			no impact		large positive impact	
1. Assignment of individual work responsibilities	1	2	3	4	5	6	7
2. Balancing workload	1	2	3	4	5	6	7

The questionnaire was provided to senior management of AAAV for their input review and approval. The survey included information regarding the purpose of the survey and advised that no individual would be specifically identified in the presentation of results.

b. Population

The population used in this study consisted of approximately 65 potential subjects employed by the Government, and 182 potential subjects employed by the Contractor/subcontractors who were collocated, and work directly with IPTs on the AAAV program. Of these 247 employees, 99 (i.e., of 65 employees of the Government and 34 employees of the Contractor/subcontractor) were selected as the target sample for the study. The population included employees at different levels in the IPT management chain.

c. Sample Selection

The research sample is focused on the AAAV collocated office. The sample consists of 99 personnel currently working throughout all levels (i.e., A-D) within the IPT structure. The individuals were selected based on their position in the IPTs and work experience to ensure a good cross-section of experience. This included administrative, managerial, and functional personnel. It also included a

wide range of years on the job, years worked on AAAV/AAV, and previous experience on IPTs (or dedicated cross-functional work teams) prior to AAAV.

ADVANCED AMPHIBIOUS ASSAULT VEHICLE (AAAV) PROGRAM

	ORGANIZATION	GOV'T (CIVILIAN & USMC)	GDAMS	SUB-CONTRACTORS
POPULATION (P)	247	65	126	56
SAMPLE (S)	**99**	**65**	**34**	**0**
# RESPOND	**58**	**40**	**18**	**0**
% RATE OF RESPONSES:				
(P)	23 %	62%	14%	0
(S)	59%	62%	53%	0

Table 3.1. Population, Selected Samples, and Response Rates Taken From AAAV's Organization, Government, the Contractor (GDAMS), and Sub-Contractors

d. Sampling Bias

Some bias may be present because the sample was limited to 99 subjects representing the AAAV organization. There is also a significant disparity in the sampling rates of the Government employees (62%) compared to the contractor/subcontractor(s)(14%). This caused the results to reflect a non-representative sample. Hence, the low sampling rate from the contractor/ subcontractor(s) may not provide a true representation of overall contractor/subcontractor(s) perspective on the impact of collocation.

e. Validity and Reliability

The surveys were developed after phone interviews with the Direct Reporting Program Manager (DRPM) and the Vice-President of General Dynamics. This helped increase the validity in the survey instrument and clarified the data being obtained. Pre-screening the questions by knowledgeable personnel from professors of the System's Management Department at the Naval

Postgraduate School, and personnel from the AAAV program office also increased the overall validity of the instrument. The availability of knowledgeable personnel to interview and survey was more than adequate, given the researcher's time constraints, and AAAV's workforce schedule commitments.

Due to the size of the study population (247 personnel) the researcher took samples from all team levels (A-D) within the organizational structure. However, the low response rate (58 responses) provided small samples at each level, limiting the ability to examine cross-level differences. This comparison was done by combining levels "A" and "B," and levels "C" and "D."

4. Analysis

The qualitative data gathered from the phone and face-to-face interviews were used to support and/or explain the analyzed quantitative data from the survey to give insight regarding the views of the respondents. The results of the interviews and survey will be used to suggest recommendations in order to expand the benefits of collocation on the AAAV program performance, and offer a benchmark for other programs as they initiate collocation.

C. SUMMARY

This chapter discussed the methodology used to investigate employees' perspectives of the impact of collocation on Integrated Product and Process Development (IPPD) towards the Advanced Amphibious Assault Vehicle (AAAV) program. Specifically, primary and subsidiary objectives concerning the use of collocated-Integrated Product Teams (IPTs) were defined and the related methodologies were presented. The first objective was to learn from the full-time members, the benefits and disadvantages of being physically collocated. The second objective was to discover the impact of collocation on specific team

processes. The third objective was to uncover the challenges and impediments, of implementing collocated-IPTs from the perspectives of full-time members.

The researcher identified key variables to developed a survey instrument. Open-ended questions solicited elaboration on two main issues: specific examples of benefits and challenges of collocation. Questions for face-to-face and phone interviews were presented. The survey was distributed, collected, and analyzed by the researcher. Ninety-nine surveys were distributed and 58 surveys were returned.

IV. DATA ANALYSIS

A. INTRODUCTION

This chapter presents and analyzes the data gathered through interviews and a survey with personnel that participated in this study from the AAAV program. Section B of this chapter provides a brief background of the AAAV organization, describing both the decisions and agreements that the Direct Reporting Program Manager (DRPM) made with the contractor; Marine Corps Systems Command (MARCORSYSCOM); and Defense Contract Management Command (DCMC), Manassas. Also, this section identifies the depth of PIPT specific training provided to all employees by the organization.

Section C incorporates data from both survey and interviews, gathered from the full-time IPT members, regarding the benefits and disadvantages of being physically collocated. Specifically, the survey data identify those specific job areas, such as defining work responsibilities and developing skills, that have been most impacted by collocation. The interview results elaborate on, and increase the reliability of results cited in the survey. For sake of anonymity, employees will be identified as "USMC," "Government Civilian," or "General Dynamics (GDAMS) employee." Finally, section D summarizes this chapter, extending the body of knowledge from the literature review discussed in Chapter II, by elaborating the benefits and challenges of implementing IPTs in a collocated environment.

B. RESEARCH SITE: AAAV ORGANIZATION

1. Background

During the Concept Exploration phase in the late 1980s, alternatives were evaluated to meet the operational requirements for vehicular transport of marines. The Marine Corps determined that a vehicle was needed to deploy marines from ship to shore and provide land mobility and firepower support for the embarked marines. A driving factor in the development of a new vehicle was the ability of

the vehicle to be deployed from over the horizon and have sufficient speed and range to rapidly reach the shore. To facilitate this rapid deployment, the vehicle had to be as lightweight as possible while providing sufficient armor protection against the small arms, indirect fire, and mine threats it is likely to face in combat. Hence, the Advanced Assault Amphibian Vehicle was determined to be the most effective means of meeting the requirements for speed, maneuverability and survivability.

In June 1996, General Dynamics Land Systems was awarded the Program Definition and Risk Reduction (PDRR) contract over its competition. The Government had included in the Request for Proposals the intent to use IPPD concept and IPTs to plan and execute the program effort. Also, the Government required each offeror's proposal to include the establishment of a facility where the contractor and Government employees could be collocated. The Direct Reporting Program Manager (DRPM) identified reduced cycle time, timely problem-solving and valuable face-to-face interaction as important reasons for utilizing collocation:

> My expectation of collocation was the absolute need to cut down cycle time from problem identification to problem resolution...[I]f you're not physically together day-in and day-out irrespective of our modern ability of telecommunications, then problems tend to bump along, people struggle with them, and then the Government gets involved at a later date and by that time, our ability to assist the Contractor in their resolutions is greatly diminished...[H]uman interaction is still the essential part of both program management and product development.

Moreover, the DRPM felt that collocation would foster a cultural change by allowing an improved mutual appreciation of the role and competence of the two parties—Government and contractor:

> The culture of the past between Government and Industry was "us vs. them.".. [The] relationship...was often confrontational...the Government historically tried to inspect in quality; the Government would use terms like "beat the contractor down..." Part of that was our lack of understanding and respect of how hard defense

contractors really work, and that was due to not seeing them very often. On the other side, the Defense Contractors historically pictured the Government employees as being "weenies" (i.e., guys with their feet upon the desk reading the paper), and did not realize the technical knowledge and how hard people worked in the Government. So by bringing them together, my expectation was to create an atmosphere of mutual respect by being able to live and work together, and exposing people to the realities of each other's culture.

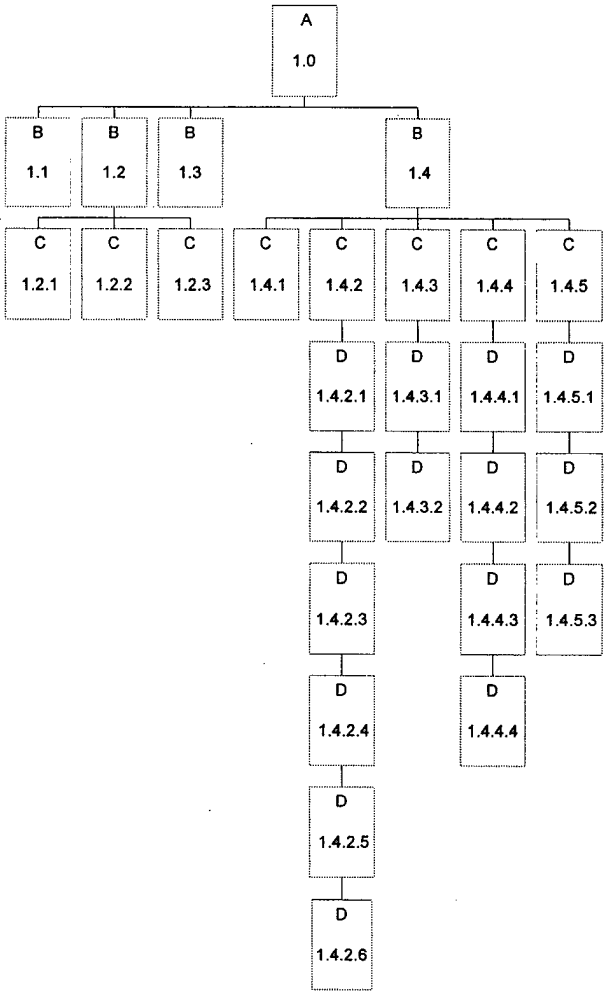
General Dynamics is not totally new to the collocation concept. For ten years, beginning in the mid 1980s, General Dynamics and the Army in Tallahassee, Florida designed, developed, and produced over 50,000 Single Channel Ground/Air Radios (SINCGARS), utilizing collocation.

Collocation was instrumental in resolving process and schedule problems through daily meetings between General Dynamics and Army personnel. Hence, General Dynamics extended this same approach to the AAAV. To facilitate collocation with the Government program management office, General Dynamics formed a new division, General Dynamics Amphibious Systems, to perform the contract. In July-August 1996, both Marine Corps personnel and Government civilians began moving in on the second floor of a 62,000 square feet facility in Woodbridge, Virginia, where GDAMS' staff (i.e., engineers and support) worked on the first floor. Government and GDAMS staffs meet daily and work together on a collocated basis utilizing IPTs.

2. Organizational Structure and Selection of Workforce

As shown in Figure 4.1, all of the program work is accomplished through IPTs. There are 28 IPTs divided into four levels that correspond roughly to the Work Breakdown Structure (WBS).

- The "A" level team deals with major program and cost issues and consists of the Executive Management Team (EMT) -- Direct Reporting Program Manager (DRPM) and Vice-President of GDAMS, as well as Program Management Team (PMT) level "B" team leaders.



WBS	IPT Area
1.0	AAAV System
1.1	Project Management
1.2	Systems Engineering
1.2.1	Modeling and Simulation
1.2.2	Logistics/ISP Special Equipment
1.2.3	Specialty Engineering
1.3	Test and Evaluation
1.4	Product Design
1.4.1	Integration and Assembly
1.4.2	Mobility Products
1.4.2.1	Suspension
1.4.2.2	Engine
1.4.2.3	Automotive Drive Train
1.4.2.4	Marine Drive
1.4.2.5	Hydrodynamic Systems and Appendages
1.4.2.6	Hydraulics
1.4.3	Firepower Products
1.4.3.1	Fire Control
1.4.3.2	Armament
1.4.4	C4I and Vetronic Products
1.4.4.1	Electrical
1.4.4.2	Communications/Navigation
1.4.4.3	Processors, Controls and Displays
1.4.4.4	Software
1.4.5	Structures and Auxiliary Systems
1.4.5.1	Hull
1.4.5.2	Auxiliary Systems
1.4.5.3	Turret Assembly

Figure 4.1. AAAV Organization Chart

Source: Developed by author.

- The "B" level teams (i.e., PMTs) are responsible for project management, system integration, test and evaluation, and production design. They maintain control over trade-off issues. (e.g., determine which subsystem will be allocated additional weight.)
- The "C" level teams (i.e., Systems Integrated Teams (SIT)) monitor and control discrete performance parameters of the vehicle, such as firepower or mobility. The level "C" items are then delegated down to the individual work package level (e.g., suspension, fire control, electrical, hull) that are performed by "D" level IPTs.
- Some ad hoc IPTs have been formed to deal with tasks such as writing the risk management plan and preparing the simulator development schedule.
- One Government-only IPT (not shown in the figure) is made up of seven division heads: personnel, communications variant, engineering, logistics, some operations, business and finance, and some contract management.

Except for the Government-only IPT, all IPTs are contractor-led with Government participation. Where appropriate, subcontractors and Government support contractors are also IPT members. All of the IPTs outlined in Figure 4.1 meet on a daily or weekly basis, requiring a significant time investment from the members. Throughout the organization, information flows from the bottom up, and the executive managers support the IPTs by ensuring that they have the necessary resources.

The Vice-President of General Dynamics and the "B" IPT leader, who is the chief engineer, select the "C" IPT leaders. The "C" IPT leaders are empowered to select the "D" IPT leaders on the basis of technical capabilities and leadership skills.

The DRPM on the other hand, hires personnel (i.e., Marines and Government civilians) organic to his office. In getting non-organic personnel and other resource support to manage the program, the DRPM has established operating agreements with the Marine Corps Systems Command

(MARCORSYSCOM), the Assistant Secretary of the Navy of Research Development and Acquisition (ASN(RDA)), and the Defense Contract Management Command (DCMC) Manassas. These agreements have provided the DRPM program management office a Procuring Contracting Officer (PCO) and legal counsel, as well as a program support team (PST). The program support team is comprised of a program integrator, Administrative Contracting Officer, specialists, and engineers, who provide Contract Administrative Services (CAS) support in the IPT environment. The PCO, legal counsel, and the PST, all work within the Project Management IPT (see Figure 4.1: Level "B" team (1.1)) of the program management team. (Moore, 1996, p. 68)

3. Training

The executive leaders of AAAV stress the importance of training. The DRPM and GDAMS Vice-President both believe that every individual working in an IPT must develop leadership qualities. It is also necessary for them to clarify the degree of decision autonomy allowed by specific teams and assure appropriate control systems are in place. According to the Vice-President of General Dynamics:

> IPTs, at first, were eager to take on the mission of being totally responsible for their own products, and having control over their own resources; but they did not have any training that would allow them to be effective at that...Initially, there was quite a bit of misunderstanding about that...IPTs thought that no one would ever question anything that they did, or they never had to get reviewed for anything...[W]e've had to do training on both sides with regard to the leadership and workforce; thus we've had to put in a lot more of processes and controls that are unique to an IPT basis.

General Dynamics has conducted formal team training using a facilitator throughout the AAAV organization; also, the Marines have provided leadership training. Generally, the training provided to all employees involves:

- An understanding of changing culturally to a high performance team-based organization
- Technical and business process (IPPD/IPT) guidance on IPTs addressing:
  - Authorization
  - Role in risk management
  - Liaison with IPTs at same level
  - Liaison with other level IPTs
  - Government roles on IPTs
  - Interaction with suppliers and subcontractors
- Management of the human side of IPTs including:
  - Trust
  - Resolving conflict
  - Communication
  - Leadership
  - Managing change
  - Group dynamics
  - Teamwork
  - Reward and recognition
  - Customer focus
- Skills needed in a high performance organization
- Expectations of an IPT leader

Appendix C outlines a set of ground rules for a typical IPT in the AAAV organization. These ground rules require that all Government and Contractor employees have a clear understanding of the issues involving procedural, technical, cost and schedule, and problem resolution. The training program improves decision making and helps resolve conflicts.

C. PRESENTATION OF QUANTITATIVE (SURVEY) AND QUALITATIVE (INTERVIEWS) RESULTS

1. Demographics

The key demographic variables used in analyzing the survey data are: (1) IPT-Role (leader or member), (2) IPT-Experience (yes or no), (3) IPT-levels (A/B or C/D); and (4) Organizational affiliation (Government: USMC, Government Civilian; GDAMS and subcontractors). The breakdown of the sample by these demographic variables are shown in Table 4.1.

	ORGANIZATIONAL AFFILIATION (4)			
	Total AAAV ORG.	USMC	GOV'T CIVILIAN	GDAMS & SUBCON-TRACTORS
(1) IPT LEVEL:				
A/B	24	1	10	13
C/D	34	9	20	5
TOTAL	58	10	30	18
(2) IPT EXPERIENCE:				
Yes	23	1	16	6
No	35	9	14	12
TOTAL	58	10	30	18
(3) IPT ROLE:				
Leader	19	3	9	7
Member	39	7	21	11
TOTAL	58	10	30	18

Table 4.1. Sample Demographics

Source: Developed by author.

The researcher looked at patterns of overall responses to identify aspects of team performance that were most significantly impacted by collocation; and those responses where impact was weak or negative. But before looking at results for the total organization, it was necessary to test for possible between-group

differences in perceptions of the impact of collocation. Four group comparisons were analyzed:

1. IPT-Level (A/B vs. C/D level teams)
2. IPT-experience (experience vs. no experience)
3. IPT-role (leader vs. member)
4. Affiliation (USMC, Government Civilian, and GDAMS)

2. Presentation of Survey Results

The results of the survey are based on respondents' ratings of the effect of collocation on varying aspects of IPT performance. There were 45 statements rated on this survey. Each of the 45 statements asked the participants to rate the impact that collocation has had on a specific aspect of team performance (e.g., identifying potential problems, liaison with customer, career opportunities, developing team goals, and reduce project cycle time). Respondents rated the impact of collocation using a Likert-type six category response choice where one equals "high negative impact" and seven equal "high positive impact" with four representing "no or neutral impact." In addition, three open-ended questions at the end of the survey, as well as data gathered from the twelve interviews (i.e., phone and face-to-face) further support and validate the employees' responses to the 45 closed-end ratings.

Each of the 45 items was categorized as fitting within one of the following five management functions: (1) task management functions, (2) boundary management functions, (3) team leadership functions, (4) performance management functions, and (5) management team outputs and dynamic functions. These categories are used to organize the presentation of results, which are provided in the following appendices:

1. Appendix D: IPT-Role; IPT-Experience; IPT-Level
2. Appendix E: USMC, Government Civilian; GDAMS

Each of these appendices presents the mean and standard deviation response by each of the group comparisons. To further discriminate comparisons made between the means of each group, a post hoc comparison of the means using a least significant difference (LSD) test was used when the initial Analysis of Variance (ANOVA), showed significant group differences ($p < .10$).

3. Results of Group Comparisons

a. IPT-Role; IPT-Experience; IPT-Level

The results of IPT: role, experience, and level group's comparison analysis show the ratings of the impact of collocation. Overall (see Appendix D), the results of IPT-Role, IPT-Experience, and IPT-Level groups perceive collocation as having a positive impact on all five management functions. In each of the three subgroup comparisons, there were no more than three out of the 45 item level t-tests that showed significant group differences. The researcher concluded that these findings were artifacts of multiple t-tests, and that all three groups view collocation about the same.

b. USMC; Government Civilian; GDAMS

The results (see Appendix E) of this analysis groups show some significant group differences. The comparisons between these separate groups show thirteen items with significant mean differences. In all but two cases, the differences show that the USMC sample rated more strongly than both Government Civilians, and GDAMS employees that collocation has had a positive impact. This is probably because ninety percent (i.e., 9 of 10) of the Marines do not have IPT experience, as compared to GDAMS' sixty-seven percent (i.e., 12 of 18) and the Government civilians' forty-seven percent (i.e., 14 of 30), respectively. Moreover, the differences may be due to Marine discipline and support of their leader (i.e., DRPM). The most significant finding here is the degree of agreement (only one significant difference out of 45 items) between GDAMS and Government Civilian respondents. Based on these subgroup comparisons of

finding primarily consistent ratings, the focus of the remainder of the analysis will be on the total sample ratings of specific items.

4. Results of AAAV Organization

An extract of Appendix E is given in Table 4.2 below, in order to present the overall major report of findings for AAAV organization.

a. Table 4.2a: Task Management Function

Description: The data in Table 4.2a show the ratings of impact of collocation. The job areas are listed in their descending order of strength of how each respondent, in the AAAV organization, rated the impact that collocation had on specific job areas categorized under task management function. The numbers represent the means and standard deviations (SD).

Task Management Function	**AAAV Organization N=(58)**	
	Means	**SD**
Identifying potential problems	6.56	(.536)
Establishing cohesiveness on project objectives	6.22	(.738)
Finding solutions to problems	6.10	(.809)
Identifying needs for coordination	6.09	(.928)
Coming up with innovative solutions to problems	6.05	(.989)
Identifying project objectives	5.78	(1.06)
Using team perspectives to sort through options	5.76	(.942)
Establishing team cohesion on values	5.68	(1.01)
Identifying areas of conflict	5.67	(.904)
Process improvements	5.66	(.919)
Effectively managing and resolving conflict issues	5.58	(.994)
Establishing decision criteria for problem solving	5.54	(.978)
Consolidating plans	5.38	(1.21)
Establishing measures of team performances	5.20	(1.04)
Assignment of individual work responsibilities	5.11	(1.13)
Clarifying decision responsibility options	4.84	(1.42)
Balancing workload	4.65	(1.19)

Table 4.2a. Total Sample Means Rating the Impact of Collocation on Items Regarding Task Management Function

Source: Developed by author.

Analysis: Overall, the AAAV organization perceives collocation as having a positive impact on task management functions. These job areas had means ranging from 6.56 (highest) to 4.65 (lowest). The total sample results show that collocation most strongly impacts the team performance areas such as "identifying potential problems" (mean = 6.56), "establishing cohesiveness on project objectives" (mean = 6.22), "coming up with innovative solutions to problems" (mean = 6.05), "finding solutions to problems" (mean = 6.10), "identifying needs for coordination" (mean = 6.09), and "identifying project objectives" (mean = 5.78). Moderate areas of positive impact agreed to by employees include "using team perspectives to sort through options" (mean = 5.76), down through "consolidating plans" (mean = 5.38).

Below are substantial qualitative findings that support the survey described above. With regards to working together on a daily basis, the twelve participants involved in the interview process all agreed that collocation allows people daily to observe what is going on and provide opportunities for issues/problems to be resolved early, thereby increasing the amount of trust. One of GDAMS employees illustrates:

> The best way to build trust is by collocation, because there is 100% visibility on a continuous basis as to what is going on. The trust is built by observing the person's performance; once you're confident that they [Government employees in IPTs] can do the job that is needed to do, then trust is built. Collocation ensures that there are no hidden agendas.

In addition, all of the interviewees agreed that collocation has allowed IPTs to proactively anticipate problems and design an action plan addressing how those problems will be jointly identified and resolved. (see Appendix C, section 4.0) Conflicts can emerge, but collocation can facilitate effective resolution. A Government employee provides an example:

> [One IPT] had not done a good job defining...[t]hings such as how do we do requirement traceability? What are the actual processes [we] have to go through this? After about six months, the [IPT] leads defined the processes, and put them out to the team for feedback. Day-to-day interaction allowed this process to get better and better.... [We] tried to work out Government and Contractor conflicts by counseling, within the teams, and in one case by use of an independent facilitator.

A GDAMS employee remarked that the training provided for IPT members on conflict resolution has been beneficial because teams must take on more responsibility for managing conflict themselves:

> IPTs brings together more disciplines; therefore, you will have more opinions, [and] conflicts that have to be resolved.... [In the past,] if some people did not agree with something, their response would be to go and talk to his/her boss. Except for the IPT leads, now there is no defined line of who is the boss; each individual shares the responsibility, so there also has to be shared responsibility into resolving conflicts.

The data above suggest the importance of building trust among team members. The impact of collocation is illustrated by the survey item, "establishing team cohesion on values" (mean = 5.68). The importance of building a common culture also emerged from interviews and qualitative comments. One of the benefits of collocation that improves areas such as "establishing team cohesion on values (mean = 5.68)," and "process improvements (mean = 5.66)" is the opportunity for employees to interact informally. One hundred percent of the interviewees talked about how collocation has allowed informal social activities to build a common culture. For example, Col. Feigley gave all employees a Fleet Marine Force-1 (FMF-1) handbook on Warfighting as a Christmas gift; in addition, GDAMS employees were invited to the Marine Corps Birthday Ball. Other informal orientation activities in which all employees have participated

include riding on an Amphibious Assault Vehicle (AAV), and visiting the Officer Candidate School in Quantico, VA. Both Government civilians and GDAMS interviewees agreed that these types of activities allow all participants exposure to understanding the Marine Corps culture and mindset of Warfighting. All in all, the data seems to suggest that IPTs have generated trust by resolving conflict and solving problems on a daily basis.

The items showing the weakest impact of collocation are "establishing measures of team performance" (mean = 5.20), "assignment of individual work responsibilities" (mean = 5.11), "clarifying decision responsibility options" (mean = 4.84), and "balancing workload" (mean = 4.65). It is likely that this is due to the IPTs' not being sufficiently mature, because the majority of employees have been collocated for less than one year. For instance, all of the interviewees suggested that working within constraints is a difficult balancing act; for example, one individual may be more interested in cost, another weight, and a third in reliability. And to establish an effective team, you have to balance out such things by prioritizing and reconciling conflicting goals. Collocation can facilitate this; but learning to prioritize and balance program goals takes time and is part of the team building and training process. A Government employee provides an illustration.

> All in all, a lot more cross talk is being addressed at the system level, which is fantastic! From a total vehicle perspective, you get a bigger mixed group of people looking at the aspects of design at the component level, which is a good thing. However, I'm not totally convinced that people are working issues effectively as they can in terms of prioritizing. For example, is cost more important than weight? Or is maintenance more important than the actual performance of the unit?

Some of the benefits of collocation from the qualitative comments, taken from the survey, reinforce the ratings of the majority of survey quantitative items reported above.

- Speed and ease of communication
- Easy face-to-face [communication] improves understanding near real-time problem resolution.
- All players available with little/no preparation required. Much time saved.
- Better awareness of program status, more detail available in shorter time.
- With team concept, all parties will have input to technical aspects (e.g., design configuration).
- With team decision making, all results are everyone's responsibility.
- No future second-guessing or criticizing-all parties involved will have those responsibilities.
- Less time is wasted when everyone (contractor and Government) agrees on the plan to meet a common set of objectives.

b. Table 4.2b: Boundary Management Functions

Description: The data in Table 4.2b show the ratings of impact of collocation. The job areas are listed in their descending order of strength of how each respondent, in the AAAV organization, rated the impact that collocation had on specific job areas categorized under boundary management function. The numbers represent the means and standard deviations (SD).

Boundary Management	AAAV Organization N=(58)	
	Means	SD
Liaison with customer	6.39	(.919)
Coordinating work with others on team	6.38	(.707)
Liaison with other IPTs	5.95	(1.04)
Involving all pertinent perspectives in decisions	5.84	(.977)
Achieving management approval of changes to program work plan (how to achieve objectives)	5.81	(.870)
Achieving management approval of project objectives	5.81	(.973)
Liaison with individual contributors outside team	5.74	(1.15)
Generating multiple options and scenarios	5.72	(1.01)
Liaison with upper management	5.67	(1.12)
Achieving management approval of project workplan	5.65	(.994)
Translating ideas/concepts into action plans	5.40	(1.21)
Liaison with supplier	5.27	(1.25)
Comparing data from multiple sources	5.20	(1.07)

Table 4.2b. Total Sample Means Rating the Impact of Collocation on Items Regarding Boundary Management Function

Source: Developed by author.

Analysis: Overall, the AAAV organization perceives collocation as having both a strong and moderate positive impact on boundary management functions. These job areas have means ranging from 6.39 (highest) to 5.20 (lowest). The total sample shows most strong positive ratings for collocation's impact on "liaison with customer" (mean = 6.39), and "coordinating work with others on team" (mean = 6.38). Moderate areas of positive impact agreed to by employees include "liaison with other IPTs" (mean = 5.74), down through "comparing data from multiple sources" (mean = 5.20). All twelve interviewees

agreed that collocation has served as a huge advantage in linking the customer with the design and development process. As a GDAMS employee puts it:

> While a few people had worked with the Marine Corps before, it was usually on a much smaller scale program; nothing was of this magnitude...the input that they [Marines] add to the process is much greater.... [I]t has been very beneficial having the Marines as customers collocated to give guidance to the contractor of what the user needs, [and] having the user's feedback on both the product and process.

Related opinions, taken from open-ended questions on the survey, are cited below. Two General Dynamics employees add that:

- Collocation facilitates customer's interface, and having access to the right individuals when needed in the development of the new vehicle.
- Direct communication with customer allows for clear understanding of the requirements and program objectives.

Moreover, Government Civilians and Marines all agreed that the most significant benefit of collocation is an increase focus of not only the customer, but that of linking other participants involved in day-to-day sharing of information through informal communication.

c. Table 4.2c: Team Leadership Function

Description: The data in Table 4.2c show the ratings of impact of collocation. The job areas are listed in their descending order of strength of how each respondent, in the AAAV organization, rated the impact that collocation had on specific job areas categorized under team leadership function. The numbers represent the means and standard deviations (SD).

Team Leadership	AAAV Organization N=(58)	
	Means	SD
Developing skills in team process/team dynamics	5.78	(.832)
Enforcing technical standards	5.43	(1.06)
Opportunities for mentoring	5.07	(1.13)
Developing and staying up-to-date on functional skills	4.96	(1.08)
Career opportunities	4.40	(1.08)

Table 4.2c. Total Sample Means Rating the Impact of Collocation on Items Regarding Team Leadership Function

Source: Developed by author.

Analysis: Overall, the AAAV organization perceives collocation as having a positive impact under team leadership management function. These job areas have means ranging from 5.78 (highest) to 4.40 (lowest). The AAAV organization agrees most strongly that collocation positively impacts job areas, such as "developing skills in team process/team dynamics" (mean = 5.78). Moderate strong impact includes "enforcing technical standards" (mean = 5.43), and "opportunities for mentoring" (mean = 5.07). At the bottom end of the listing in Table 4.2c are the job areas, "developing and staying up-to-date on functional skills" (mean = 4.96), and "career opportunities" (mean = 4.40). These ratings, in particular, seem to suggest that a gap exists between the leadership requirements at the team level and leadership capability. For instance, all of the interviewees identified that there is a unique requirement from senior management in managing collocated teams. In particular, they suggested that IPTs are being built with people of technical expertise, and not necessarily with leadership expertise. According to one of GDAMS employees:

> General Dynamics brought 35 lead engineers who can take a group of engineers and work with them in solving equations and problems. Some [IPT leaders] are strong leaders, but some are weak. But all

> are technically sound.... Sometimes, IPT leads may undermine group ideas, as critical decisions are being advanced up to the next level IPT (e.g., "D" to "C").

The executive managers are aware of this shortfall; hence, leadership is being emphasize as one of the major areas focused on when IPT leaders are being trained. The Vice-President of General Dynamics stressed:

> [L]eadership needs to be involved in some things, because they affect several or many IPTs, or the team's decision would have such a large impact that the decision would still have to get reviewed and agreed to by supervision. Hence, we've had to put in some processes in place to identify when higher-level leadership involvement [is] necessary.

d. Table 4.2d: Performance Management Function

Description: The data in Table 4.2d show the ratings of impact of collocation. The job areas are listed in their descending order of strength the overall ratings of the impact that collocation had on specific job areas categorized under performance management function. The numbers represent the means and standard deviations (SD).

Performance Management	**AAAV Organization N=(58)**	
	Means	**SD**
Reviewing team performance	5.83	(.818)
Developing team goals	5.78	(.832)
Developing individual goals	4.71	(.916)
Accuracy of performance appraisals	4.44	(.984)
Handling disciplinary problems	4.30	(.944)

Table 4.2d. Total Sample Means Rating the Impact of Collocation on Items Regarding Performance Management Function

Source: Developed by author.

Analysis: Overall, the AAAV organization perceives collocation as having a positive impact under the performance management function. These job areas have means ranging from 5.83 (highest) to 4.30 (lowest). Thus, the AAAV organization agrees most strongly that collocation positively impacts job areas, such as "reviewing team performance" (mean = 5.83), and "developing team goals" (mean = 5.78). The items showing the weakest positive impact of collocation are "developing individual goals" (mean = 4.71), "accuracy of performance appraisals" (mean = 4.44), and "handling disciplinary problems" (mean = 4.30).

Although GDAMS employees felt that there was a mutual understanding of Government and contractor goals that contributed towards developing personnel along with business relationships, a majority reported problems in team cohesion; collectively, they tended to believe that:

> Not all personnel have grasped the IPT philosophy. Some IPTs have developed a strong IPT identity/team attitude, but do not include supporting personnel (i.e., the "ilities": producibility, maintain-ability)

On the other hand, the Government Civilians and Marines feel that there may be inherent goal differences among team members:

> The Government participants are not equal team members. From a legal standpoint, the contractor is still ultimately responsible for seeing that the required work is accomplished. This will be the Contractor's focus and understandably so. For the Government participants, their obligation and responsibility extends beyond the contract period of performance. The Government participants are not worried about corporate profits but rather what is in the best interest of their customer for the system's life cycle. For this reason, the Government and Contractor do not share exactly the same objectives and risks.... Occasional personality conflicts arise. Upper management sometimes tends to use the information flow to apply

significant pressure to employees. This results in some shut down of the information flow.

In regard to "accuracy of performance appraisals" (mean = 4.44), the Government currently does not have a reward incentive program in place for its employees. However, General Dynamics provides rewards to its employees through a share award plan and an incentive award fee, based on meeting certain criteria as determined by a committee from the Government. Two GDAMS employees share their views on these issues:

> Collocation allows people see the outcome of their work. We will see a vehicle roll out of the door in 1999. We will see both successes and failures. Most of the people like what we're going to achieve. And that's going to be the biggest reward.

> Some of the civilian employees feel they should perhaps take part in receiving awards for their input in team's performance. Being collocated may disincentivise employees in performing as well as their potential.

Hence, the low rating may suggest the need to look at incentivising team performance as well as individual performance.

Table 4.2d also seems to show a weak confidence in "handling disciplinary problems" (mean = 4.30). This may be contributed to team members having to adjust to confronting an individual misbehavior in a collocated-IPT environment.

e. Table 4.2e: Management Team Outputs and Dynamics Function

Description: The data in Table 4.2e show the ratings of impact of collocation. The job areas are listed in their descending order of strength of the total group's ratings of the impact that collocation had on specific job areas

categorized under boundary management function. The numbers represent the means and standard deviations (SD).

Management Team Outputs and Dynamics	AAAV Organization N=(58)	
	Means	SD
Reduced project cycle time	6.05	(.970)
Improved negotiation of design trade-offs	5.95	(1.04)
Improved efficiency of resource use	5.84	(1.21)
Increased time-wasting conflicts	4.22	(1.36)
Increased amount of time in meetings that are not value added	3.96	(1.59)

Table 4.2e. Total Sample Means Rating the Impact of Collocation on Items Regarding Management Team Outputs and Dynamics Function

Source: Developed by author.

Analysis: Overall, the AAAV organization perceives collocation as having a positive impact under management outputs and dynamics function. These job areas have means ranging from 6.05 (highest) to 3.96 (lowest). The AAAV Organization give the strongest rating to the positive impact of collocation on job areas, such as "reduced project cycle time" (mean = 6.05), "improved negotiation of design trade-offs," (mean = 5.95) and "improved efficiency of resource use" (mean = 5.84).

Based on the interviews and open-ended survey questions, Government Civilians, Marines, and GDAMS employees collectively agree that collocation provides significant benefits in terms of cycle time, efficiency and design. With regards to cycle time, a Government Civilian employee notes:

> [When not collocated it] generally takes 2-3 weeks to coordinate documents. For example, the contractor surfaces an issue, Government then comments, Contractor comes back with questions.

> In a [collocated-] IPT environment issues can be discussed on the spot. Collocation has allowed coordination time to be reduced by 50% or more.

In regard to efficiency and design, comments from USMC employees observe that collocation benefit IPTs in a number of ways:

- Having the ability to do immediate mediation on impractical designs.
- No lag time between system design reviews and critical design reviews.
- Ability to meet with individual team members or whole team at any time. Can turn around and discuss comments on documents with minimum delay.
- Discussing and receiving classified information is simplified.

There are similar observations made by General Dynamics personnel regarding productivity and efficiency, information flow, and attitude. One employee observes that:

> Productivity and efficiency have doubled. [We are] more likely to develop product that meets customer's needs.... More timely control of negotiation and definitization.

The majority of General Dynamics employees agree that collocation has improved information flow:

> [Collocation] allows "the AAAV team" to have access to all information on a real time basis which saves time and gives each individual the opportunity to excel and be part of the process. Information flow results in the ability to accurately assess cost, schedule, risk, and the product's level of technical maturity.... Dynamic interaction among functional groups--logistic, design, cost, producibility.

Similarly, the majority of General Dynamics employees agree that collocation:

- [Allows] access to personnel and information.... Virtual Design Database allows immediate access after posting and notification of new data availability.
- Decrease time in having questions answered.... Allow for joint input to products/reports more easily.... Sharing of resources.... Less an "us vs. them" attitude.
- Reduce paper work.

In contrast to the benefits cited above, USMC personnel, Government Civilians, and General Dynamics employees express some issues/concerns as a result of collocation. Some of these concerns include: room availability, separation from other corporate resources, and micro-management. A majority of USMC and Government Civilians employees collectively stated comments similar to the following:

> With 28 IPTs and many smaller working groups, meeting room availability has become a problem.... Need more rooms with centralized scheduling capability.

One General Dynamics employee adds that: "Collocation means separation from other corporate assets such as sensors [division] and [the] software [design organization]." Moreover, a significant number of General Dynamics employees consistently describe their concerns to include: overhead strain on allocated resources, micro-management by the customer, and customer's role in team dynamics. For instance, General Dynamics employees observe:

> The overhead associated with day-to-day communication and customer direction can put strain on allocated resources i.e., there is increased potential for unplanned effort in response to the diverse input from team members.
>
> The biggest concern is that collocation seems to be evolving into micro-management. For instance, is it necessary for the end user to see every single idea that the engineers come up with? We seem to

be spending more time documenting what we are doing than actually designing anything.... Over-management by Government becomes more likely.

Customer does not always understand the design process. Customer seems frustrated with experiencing day-to-day setbacks which are to be expected in a DEM/VAL program. In a normal [non-collocated] environment, the customer would not observe or be part of this process.

Requirements can be changed frequently. Design of product is very dynamic since [there is] not a concrete specification. Government representatives' ask for more information or data from GDAMS, resulting in loss of time.... Opinions of the Marines may sometimes unnecessarily delay the big decisions while minor points are beat[en] to death. Overall these concerns are minor.

At the bottom end of the listing in Table 4.2e are two job areas, "increased time-wasting conflicts" (mean = 4.22), and "increased amount of time in meetings that are not value added (mean = 3.96)." The organization tends to agree that effective meetings are still an ongoing challenge. The following comments taken from the open-ended comment section of the survey illustrate the majority of the respondents' concerns:

- No time to do work [because of] meetings, [and] working [in] groups.
- Obligations of IPT members to attend many other IPT meetings or [there is] too much time spent in unnecessary meetings.
- Having greater insight into technical issues means constantly working problems with large groups. Inefficient--causes time-waste, takes toll on our own management techniques. We do more-but too much falls to [the waste] side. This issue has lessened somewhat due to agendas being developed and posted prior to meetings but some IPTs still don't post agendas and many [IPTs] only post to designated IPT members.

A Government Civilian employee provides an illustration of the costs and benefits of the time commuted IPT work:

> [Say] somebody had six meetings today. If you think of those meetings as work, then maybe that is what we should be doing all day is meeting; maybe that's how you get the information you need to make decisions. Sitting at your desk working on your computer may not be what you should be doing. [It may be preferable but] it may not be how you can actually get the job done; that gets people frustrated, because they feel effective in their office. All in all, people generally feel productive in the office and non-productive in meetings. For example, if you want to design a display, you have to sit in a meeting with people looking at a screen up there addressing pluses or minuses, pushing this button and that button, making it happen. That's a meeting that took eight hours; now is that a waste of your time? [It could be a] good thing or a bad thing. I personally feel that that [i.e., these sorts of meeting] is a good thing, but there are others who would disagree.... The value of meetings in a collocated environment far outweighs the time I spent in meetings that I shouldn't have been in. We don't run effective meetings, but we tend to get the job done. For example, it may take two hours, where it should have only taken 45 minutes; however two hours beat 3 days [if we were non-collocated], because we did not have to send letters here; ask 47 people to come from Detroit, and higher ups to come down.

A General Dynamics employee adds that: "Being not prepared prolongs meetings. Some people attend meetings that they don't need to be at. The key is to figure out which meeting is relevant. " These comments seem to suggest that people should understand that meetings are inherent in the design of the product, and that time management in a collocated environment is a challenge for employees, and it will take some period for them to adjust to this kind of environment and develop the skills to improve efficiency.

All in all, team management consists of group dynamics and managing change. First, with regard to group dynamics, part of the training

provided to all employees within the AAAV organization is teaching interpersonal dynamics (i.e., how to work effectively within groups, and communicate across groups). All of the interviewees agreed that collocation has facilitated this process; thus, allowing decisions to come to closure more quickly. Second, with respect to managing change, it is very difficult to say at the beginning of the program what you're going to be developing three years out, because the design of the product may change. One hundred percent of the interviewees concurred that collocation improves this sort of process, because information flows easier, people understand the problem, and they can agree to it. Moreover, IPTs are more informed about what goes on.

During the survey and interviews, members of the AAAV organization had some great insights and recommendations consistent with findings discussed in this chapter. Appendix F provides salient recommendations that reinforce survey results taken from the open-ended question(s) in the survey, and interviewees. These bulletized observations provides additional insights into expanding the benefits of collocation on AAAV performance. The key recommendations include:

- Continuous in-depth training on how incentives relate to process/team performance.
- Educating the customer about the pitfalls in a new weapon system from the perspective of the contractor.
- Continuous improvement of information flow across IPTs.
- Setting up days or blocks of having no meetings.
- Establishing a very active issue resolution procedure that allows for continuous progress and team satisfaction.

D. CHAPTER SUMMARY

This section summarizes this chapter, extending the body of knowledge from the literature discussed in Chapter II, and highlighting the benefits and challenges and impediments of implementing IPTs in a collocated environment. The discussion will be organized into three subsections:

- Background and Structure
- Training
- Employees' Perception of Collocation

1. Background and Structure

The Marine Corps' Advanced Amphibious Assault Vehicle (AAAV) is the first major defense acquisition program (MDAP) being designed and developed using Integrated Product and Process Development (IPPD) as the process and collocation as the primary method of integrating technical and business expertise into Integrated Product Teams (IPTs).

The twenty-eight IPTs are organized hierarchically into four level-IPTs comprised of an Executive Management Level ("A") Team, a Program Management Level ("B") Team, a Systems Integration Level ("C") Team, and working level ("D") IPTs, that all participate in designing, developing, and administering the program. In particular, the level "B," "C," and "D" teams within the AAAV Organization are differentiated horizontally according to subsystems and components. The AAAV Organization consists of approximately 250 employees representing the Government (Marines and civilians), Contractor--General Dynamics (GDAMS), and subcontractors.

The Direct Reporting Program Manager (DRPM) identified reduced cycle time, timely problem solving, and valuable face-to-face interaction as important

reasons for utilizing collocation. Also, he anticipated that collocation would foster a culture change.

Link to Literature

The AAAV Organization clearly shows the characteristics of a dedicated Program level-Integrated Product Team (PIPT) utilizing IPPD concepts. IPTs are collocated which fosters on a daily basis some of the principles and characteristics of IPTs identified by DOD Regulation 5000.1 (1996), and Lopez (1994):

- Open discussions with no secrets
- Qualified, empowered team members
- Consistent, success oriented, proactive participation
- Continuous 'up the line' communication
- Issues raised and resolved early
- Team is set up to produce a specific product or service
- Multi-disciplinary-all team members working together towards a common goal
- Members have mutual, as well as individual accountability
- Empowered, within specific product or service goals to make decisions
- Planned integration among teams toward system goal

  Teams may be created in a horizontal or vertical relationship with other teams.

2. Training

There is specific training being conducted throughout the AAAV Organization. Both the DRPM and Vice-President of General Dynamics are heavily involved in this process.

In assembling IPTs, a facilitator has taught a wide range of subjects that would need to be taught to any defense related IPT. The difference may be that

Marines assigned to the program instruct all IPT members on basic leadership. Facilitator-led training includes:

- An understanding of changing culturally to a high performance team-based organization
- Technical and business process (IPPD/IPT) guidance on IPTs addressing:
  - Authorization
  - Role in risk management
  - Liaison with ipts at same level
  - Liaison with other level IPTs
  - Government roles on IPTs
  - Interaction with suppliers and subcontractors
- Management of the human side of IPTs including:
  - Trust
  - Resolving conflict
  - Communication
  - Leadership
  - Managing change
  - Group dynamics
  - Teamwork
  - Reward and recognition
  - Customer focus
- Skills needed in a high performance organization/expectations of an IPT leader

Both DRPM and Vice-President of GDAMS firmly believe that training provides direction, momentum, and commitment to mold employees into working in a team-based collocated environment.

Link to Literature

Mohrman, Cohen, and Mohrman (1995) stress the importance of education and training processes being ongoing where members continuously learn from their technical mentors, formal training, informal training, experience, and from each other on team skills, interpersonal conflict resolution skills, and decision making skills. Collocation facilitates these processes by allowing team members to influence others, manage meetings, and communicate more effectively toward solving problems and resolving issues.

3. Employees Perception of Collocation

The participants of this study overall agreed that collocation has had a strong positive impact on many aspects of team performance. In particular, the study participants report that collocation has allowed informal social activities in building a common culture, thereby generating trust in resolving conflict and solving problems on a daily basis.

In regard to the five management functions (i.e., task, boundary, leadership, performance, outputs and team dynamics), the data in this chapter show that the AAAV Organization, overall, perceives collocation as having a positive impact. The ten strongest areas include the following, where a maximum rating of seven indicated very strong positive impact:

Job Areas	Means
• Identifying potential problems	6.56
• Liaison with customer	6.39
• Coordinating work with others on team	6.38
• Establishing cohesiveness on project objectives	6.22
• Finding solutions to problems	6.10
• Identifying needs for coordination	6.09
• Reduced project cycle time	6.05

•	Coming up with innovative solutions to problems	6.05
•	Liaison with other IPTs	5.95
•	Improved negotiation of design trade-offs	5.95
•	Involving all pertinent perspectives in decisions	5.84
•	Improved efficiency of resource use	5.84
•	Reviewing team performance	5.83
•	Achieving management approval of changes to program work plan (how to achieve objectives)	5.81
•	Achieving management approval of project objectives	5.81
•	Developing team skills in team process / team dynamics	5.78
•	Developing team goals	5.78
•	Identifying project objective	5.78

The survey results also indicates areas where collocation has not yet had a strong positive impact. These include:

	Job Areas	**Means**
•	Developing and staying up-to-date on functional skills	4.96
•	Clarifying decision responsibility options	4.84
•	Developing individual goals	4.71
•	Balancing workload	4.65
•	Accuracy of performance appraisals	4.44
•	Career opportunities	4.40
•	Handling disciplinary problems	4.30
•	Increased time-wasting conflicts	4.22
•	Increased amount of time in meetings that are not value added	3.96

Link to Literature

The results and analysis of this chapter validate that the steps taken by the DRPM and Vice-President of GDAMS, follow the research-based guidance presented in Chapter II by Mohrman, Cohen, and Mohrman (1995):

- Aligning the team's systematic measures and processes
- Supporting the team in adopting measures and processes
- Supporting the team in adopting and maintaining high standards
- Ensuring all team members understand performance expectations
- Ensuring team members get required training
- Ensuring that IPTs are aware of the organizational policies and charters.

Crow (1995) adds that being collocated:

- Enhances the frequency and quality of communication,
- Provides greater opportunity for feedback and discussion,
- Provides better coordination of team activities,
- Allows team members to respond more rapidly to issues and initiate process tasks more quickly
- Decreases infrastructure requirements such as technical networks, document distribution, and secretarial support

Again, both qualitative and quantitative results from this chapter confirm these statements.

DiTrapani and Geither (1996) stated that "establishing IPTs in a collocated environment may require more resources (e.g., capital, costs, labor, and training) early in the development phase." However, they found that the consensus between both industry and Government entities favored the idea of collocation because the return will result in:

- Superior designs
- Reduced resources over the life cycle of development production and support through reduced design/build/test iterations
- Less efforts to correct initial design deficiencies through engineering changes
- Less effort to manufacture, test, fix, and support the product

Crow (1995) adds that "the IPT approach in a collocated environment will lead to greater commitment to the design and will result in a smoother transition to production." The AAAV program, since its implementation in June 1996 validates these comments.

V. CONCLUSIONS AND RECOMMENDATIONS

A. INTRODUCTION

This thesis has examined the implementation of collocated-Integrated Product Teams (IPTs) at the Marine Corps' Advanced Amphibious Assault Vehicle's (AAAV's) program and analyzed the benefits and disadvantages from the perspectives of the USMC Program Management Office and General Dynamics, the Contractor.

From both qualitative (interviews) and quantitative (survey) data, the researcher assessed the impact of collocation on the AAAV program, and established a baseline for evaluating the effects of collocation. The research results from this study elaborate the benefits of collocation on AAAV program, and offers a benchmark for other programs as they initiate collocation.

Section "B", of this chapter concludes this study by first, identifying the major success areas of collocation, and second, identifying the positive but marginal areas of collocation, indicating room for improvement. Section "C" suggests recommendations developed from this study, and identifies potential areas for future research.

B. CONCLUSIONS

This research was undertaken to seek insights into implementation of collocated-Integrated Product Teams (IPTs) at the Advanced Amphibious Assault Vehicle (AAAV) program. Employees ratings (See Appendices D and E) indicate that the personnel, overall, perceive collocation as having a positive impact on the job areas specified under the management functions (i.e., task, boundary, team leadership, performance, and management team outputs and dynamics).

"Best" Job Areas

In particular, the strongest areas where benefits of collocation are being derived include the following:

- Identifying potential problems
- Liaison with customer
- Coordinating work with others on team
- Establishing cohesiveness on project objectives
- Finding solutions to problems
- Identifying needs for coordination
- Reduced project cycle time
- Coming up with innovative solutions to problems
- Liaison with other IPTs
- Improved negotiation of design trade-offs

"Potential Growth" Job Areas

The survey results also indicates areas where collocation has not yet had a strong positive impact. These include:

- Developing and staying up-to-date on functional skills
- Clarifying decision responsibility options
- Developing individual goals
- Balancing workload
- Accuracy of performance appraisals
- Career opportunities
- Handling disciplinary problems
- Increased time-wasting conflicts
- Increased amount of time in meetings that are not value added

Overall, findings show consistent positive impact of collocation. Yet, the data shown in tabular form in Chapter IV points out which job areas need more

attention than others in training IPTs to operate in a collocated environment. These data show what experience has taught team members, IPT leads, and the EMT about implementing IPTs in a collocated environment.

C. RECOMMENDATIONS AND FOLLOW-ON RESEARCH

1. Recommendation #1

On the most positive attributes, identify metrics and periodically measure to be sure that these benefits continue to be achieved. As far as those areas that show collocation not having a strong positive impact, look for remedial action/training to improve these areas.

2. Recommendation #2

Consider readministering the survey in **Appendix B** in six months to gage progress in the assessed impact of collocation. Now that the less experienced personnel have gained insights into collocation, strive for 100% participation when readministering the survey. This can be accomplish by a Naval Postgraduate student as follow-on research.

3. Recommendation #3

The experiences of employees in the AAAV organization that are reflected in this study suggest other interesting new avenues of research. This study examined only the impact of collocation of IPTs, and not IPT's overall effectiveness. A follow-on thesis could examine IPT effectiveness.

4. Recommendation #4

Initiate an intensive case study to look at unique aspects/ requirements/processes of IPTs at different levels, or focusing on one entity's within Government, Contractor, or subcontractor organizations. This study can be accomplished by a Naval Postgraduate student as follow-on research.

5. Recommendation #5

Appendix F provides salient recommendations that reinforce survey results taken from the open-ended question(s) in the survey, and interviewees. These bulletized observations provides additional insights into expanding the benefits of collocation on AAAV performance.

APPENDIX A. TEN TENETS OF INTEGRATED PRODUCT AND PROCESS DEVELOPMENT (IPPD)

1. Customer Focus - The primary objective of IPPD is to satisfy customer's needs better, faster and at less cost. The customer needs should determine the nature of the product and its associated processes.

2. Concurrent Development of Products and Processes - Processes should be developed concurrently with products which they support. It is critical that the processes used to manage, develop, manufacture, verify, test, deploy, operate, support, train people, and eventually dispose of the product be considered during development. Product and process design and performance should be kept in balance.

3. Early and Continuous Life Cycle Planning - Planning for a product and process should begin early in the science & technology phase (especially advanced development) and extend throughout the product's life cycle. Early life cycle planning, which includes customers, functions, and suppliers, lays a solid foundation for the various phases of a product and its processes. Key program events should be defined so that resources can be applied and the impact of resource constraints better understood and managed.

4. Maximize Flexibility for Optimization and Use of Contractor Unique Approaches - Requests for Proposal (RFP's) and contract should provide maximum flexibility for optimization and use of contractor unique processes and commercial specifications, standards and practices.

5. Encourage Robust Design and Improved Process Capability - Encourage use of advanced design and manufacturing techniques that promote achieving quality through design, products with little sensitivity to variations in the manufacturing process (robust design) and focus on process capability and

continuous process improvement. Utilize such tools as "Six-Sigma" process control and lean/agile manufacturing concepts to advantage.

6. Event Driven Scheduling - A scheduling framework should be established which relates program events to their associated accomplishments and accomplishment criteria. An event is considered complete only when the accomplishments associated with the event have been completed as measured by the accomplishment criteria. This event-driven scheduling reduces risk by ensuring that product and process maturity are incrementally demonstrated prior to beginning follow-on activities.

7. Multidisciplinary Teamwork - Multidisciplinary teamwork is essential to the integrated and concurrent development of a product and its processes. The right people at the right place at the right time are required to make timely decisions. Team decisions should be based on the combined input of the entire team (e.g., engineering, manufacturing, test, logistics, financial management, contracting personnel) to include customers and suppliers. Each team member needs to understand their role support the role of the other members, as well as understand the constraints under which other team members operate. Communication within teams and between teams should be open with team success emphasized and rewarded.

8. Empowerment - Decisions should be driven to the lowest level commensurate with risk. Resources should be allocated at levels consistent with authority, responsibility, and the ability of the people. The team should be given authority, responsibility, and resources to manage their product and its risk commensurate with the team's capabilities. The team should accept responsibility and be held accountable for the results of their effort.

9. Seamless Management Tools - A framework should be established which relates products and processes at all levels to demonstrate dependency and interrelationships. A single management system should be established that relates requirements, planning, resource allocation, execution, and program tracking over the product's life cycle. This integrated approach helps ensure teams have all available information thereby enhancing team decision-making at all levels. Capabilities should be provided to share technical and business information throughout the product life cycle through the use of acquisition and support databases and software tools for accessing, exchanging, and viewing information.

10. Proactive Identification and Management of Risk - Critical cost, schedule and technical parameters related to system characteristics should be identified from risk analyses and user requirements. Technical and business performance measurement plans, with appropriate metrics, should be developed and compared to best-in-class industry benchmarks to provide continuing verification of the degree of anticipated and actual achievement of technical and business parameters.

Source: SECDEF MEMO May 10, 1995

APPENDIX B. AAAV SURVEY

DEMOGRAPHICS:

The following information is needed to help us with statistical analysis of the data. Individual responses will not be seen by anyone at AAAV.

1. Employer (check appropriately):

____Government: USMC
____Government: Civilian
____Government: Other (please specify) _____
____General Dynamics
____Other subcontractor (please specify) _____

2. a. How long have you worked for this employer? _____ years

   b. How long have you held your current job position? _____ years

   c. How long have you worked on AAAV? _____ months / years

   d. Before AAAV, did you work on AAV? _____ yes _____ no
   If yes, for how long? _____ years

3. For the IPT which is your primary assignment:

   a. What is your role? (check one)

   ____ team leader
   ____ team member

   b. Name of IPT _____

   c. Team level? (check one)

   _____ A
   _____ B
   _____ C
   _____ D

4. How many other IPTs are you assigned to? _____

5. Have you had previous experience on IPTs (or dedicated cross-functional work teams) prior to AAAV? Yes___ No___

INSTRUCTIONS: Answer all items according to your initial reaction and circle the number to rate each question using one of the following response categories:

1 = large negative impact
2 = moderate negative impact
3 = small negative impact
4 = no impact
5 = small positive impact
6 = moderate positive impact
7 = large positive impact

Note: Collocation is the physical proximity of the various individuals, teams, functional areas, and organizational subunits involved in the development of a particular product or process. For the purpose of this survey, "physical proximity" means "within walking distance"-next door or next floor, in the same building.

RATE THE IMPACT THAT COLLOCATION HAS ON YOUR TEAM'S ABILITY TO ACCOMPLISH THE FOLLOWING:

	large negative impact			no impact			large positive impact
Task Management							
Assignment of individual work responsibilities	1	2	3	4	5	6	7
Balancing workload	1	2	3	4	5	6	7
Identifying project objectives	1	2	3	4	5	6	7
Establishing cohesiveness on project objectives	1	2	3	4	5	6	7
Identifying potential problems	1	2	3	4	5	6	7
Finding solutions to problems	1	2	3	4	5	6	7
Identifying needs for coordination	1	2	3	4	5	6	7
Identifying areas of conflict	1	2	3	4	5	6	7
Effectively managing and resolving conflict issues	1	2	3	4	5	6	7
Process improvements	1	2	3	4	5	6	7
Establishing team cohesion on values	1	2	3	4	5	6	7
Establishing decision criteria for problem solving	1	2	3	4	5	6	7

RATE THE IMPACT THAT COLLOCATION HAS ON YOUR TEAM'S ABILITY TO ACCOMPLISH THE FOLLOWING:

	large negative impact			no impact			large positive impact
Clarifying decision responsibility	1	2	3	4	5	6	7
Using team perspectives to sort through options	1	2	3	4	5	6	7
Consolidating plans	1	2	3	4	5	6	7
Coming up with innovative solutions to problems	1	2	3	4	5	6	7
Boundary Management							
Coordinating work with others on team	1	2	3	4	5	6	7
Liaison with individual contributors outside team	1	2	3	4	5	6	7
Liaison with other IPTs	1	2	3	4	5	6	7
Liaison with customer	1	2	3	4	5	6	7
Liaison with supplier	1	2	3	4	5	6	7
Liaison with upper management	1	2	3	4	5	6	7
Developing and staying up-to-date on functional skills	1	2	3	4	5	6	7
Achieving management approval on project objectives	1	2	3	4	5	6	7
Achieving management approval of project workplan	1	2	3	4	5	6	7
Achieving management approval of changes to program work plan (how to achieve objectives)	1	2	3	4	5	6	7
Comparing data from multiple sources	1	2	3	4	5	6	7
Generating multiple options and scenarios	1	2	3	4	5	6	7
Translating ideas/concepts into action plans	1	2	3	4	5	6	7
Involving all pertinent perspectives in decisions	1	2	3	4	5	6	7

RATE THE IMPACT THAT COLLOCATION HAS ON YOUR TEAM'S ABILITY TO ACCOMPLISH THE FOLLOWING:

	large negative impact			no impact			large positive impact
Team Leadership							
Developing and staying up-to-date on functional skills	1	2	3	4	5	6	7
Developing skills in team process / team dynamics	1	2	3	4	5	6	7
Opportunities for mentoring	1	2	3	4	5	6	7
Enforcing technical standards	1	2	3	4	5	6	7
Career opportunities	1	2	3	4	5	6	7
Performance Management							
Developing team goals	1	2	3	4	5	6	7
Developing individual goals	1	2	3	4	5	6	7
Reviewing team performance	1	2	3	4	5	6	7
Handling disciplinary problems	1	2	3	4	5	6	7
Accuracy of performance appraisals	1	2	3	4	5	6	7
Management Team Outputs and Dynamics							
Reduced project cycle time	1	2	3	4	5	6	7
Improved efficiency of resource use	1	2	3	4	5	6	7
Improved negotiation of design trade-offs	1	2	3	4	5	6	7
Increased time-wasting conflicts	1	2	3	4	5	6	7
Increased amount of time in meetings that are not value added	1	2	3	4	5	6	7

APPENDIX C. GROUND-RULES FOR A TYPICAL IPT

1.0 Procedural

1.1 IPT meetings shall be conducted to provide broad, multi-disciplined review and input of the IPT's engineering work products. The meetings shall facilitate early, in process reviews to identify specialty engineering, supportability, and other issues such that corrections and/or changes are incorporated prior to the release of the engineering product.

1.2 Meeting frequency shall be determined by the IPT lead and scheduled as required, to meet the needs of the IPT system engineering designs (SEDS) for the development and release of engineering products.

1.3 Published agendas shall be prepared and distributed prior to the meeting. It is highly desirable that any material to be discussed or reviewed and release of engineering products.

1.4 Meeting minutes shall be prepared and saved in the IPT VDD database. The minutes shall, as a minimum, document any IPT decisions and action items assigned.

1.5 Each IPT shall maintain an action item list. Action Item completion shall be tracked and status reviewed as appropriate. The IPT action item list shall be saved in the IPT VDD.

1.6 Each IPT shall maintain an "Issues Parking Lot". The "Issues Parking Lot" shall be used to capture issues, which are outside the scope of the current discussion but are important enough to save for later discussions. This can also be used to collect issues, which are not ready to be worked and should be considered at a later date. This issue list shall, at a minimum, describe the issue and identify when the issue needs to be addressed.

1.7 The ground-rules for Government representative participation in the IPT shall consist of the following:

- The IPTs are GDAMS run entities. Government does not lead or manage the IPTs.
- Government serves as "customer" representatives on the IPTs. They are there to REDUCE THE CYCLE TIME of contractor-Government (customer) communication. Hence, the Government facilitates GDAMS personnel getting Government input faster. Government IPT members also enable GDAMS IPT Status and issue

information up the Government chain on a daily basis (instead of monthly or quarterly).

- GOVERNMENT DO NOT DO GDAMS' IPT WORK, or any portion of their work or tasks. GDAMS has been contracted to perform the tasks outlined in the contract statement of work (SOW); their personnel and their subcontractors' personnel will perform those tasks, not us. **But Government IPT members will be an active part of the deliberations during the development of, and participate in "on-the-fly" reviews of deliverables called out in the contract data requirement lists (CDRL's).**
- When asked by GDAMS personnel for the Government's position or interpretation, Government IPT members can offer their personal opinion, as an IPT member, or offer expert opinion; member can provide guidance as to our "customer" opinion and what might be acceptable to the Government but the member can only offer the "Government" position for items that have been agreed to by the member and the member's
- Supervisor. IT IS UP TO THE GOVERNMENT REPRESENTATIVE SUPERVISORS TO EMPOWER EACH OF ITS MEMBERS TO AN APPROPRIATE LEVEL OF AUTHORITY. It is expected that this will start at a minimal level of authority and be expanded as each individual's IPT experience and program knowledge grows.
- Government IPT members CANNOT authorize any changes or deviations to/from the contract SOW or Specifications. **Government IPT members can participate in the deliberations and discussions that would result in the suggestion of such changes.** If/When and IPT concludes that the best course of action is not in accordance with the contract, and a contract change is in order, then GDAMS must submit a Contract Change Request (CCR) through normal channels.
- Government IPT members CANNOT authorize GDAMS to perform work that is in addition to the SOW/contract requirements. GDAMS IPTs can perform work that is not specifically required by the contract, at their discretion (provided they stay **within the resources as identified in the Team Operating Contract (TOC).**
- Government IPT member participation in GDAMS IPT activities IS NOT Government consent that the work is approved by the

Government or is chargeable to the contract. If an IPT is doing something questionable, identify it to your supervisor or PMT member.

- Government members of IPTs do not approve or disapprove of IPT decisions, plans, or reports. You offer your opinion in their development, you vote as a member, and you coordinate issues with your Supervisor and bring the "Government" opinion (in the form of your opinion) back to the IPT, with the goal of improving the quality of the products; you don't have veto power.
- Government IPT members are still subject to all the Government laws and regulations regarding "directed changes," ethics, and conduct. **Your primary function is to perform those functions that are best done by Government employees, such as:**
  - **Conveying to GDAMS personnel your knowledge/ expertise on Marine Corps operations and maintenance techniques**
  - **Interfacing with all other Government organizations (e.g. T&E)**
  - **Control/facilitization of GFE and GFM**
  - **Ensuring timely payment of submitted vouchers**
  - **Full participation in Risk Management and the resulting**

2.0 Technical

2.1 D level IPTs shall present and review key technical decisions at the C level. The C level IPT shall assure that D level design decisions are supportive and consistent with the overall integrated C4I & Vetronic performance requirements.

2.2 The D level IPTs shall communicate all configuration changes, which affect any LRU external interface to the C level. The C level IPT shall assure that D level configuration changes are supportive and consistent with the overall integrated C4I & Vetronic performance requirements.

2.3 The D level IPTs shall present weight status and explain all weight changes to the C level each month, at a minimum (prior to Weight Report Release) or when a significant weight change occurs.

3.0 Cost & Schedule

3.1 It is the IPT leads responsibility to orchestrate, lead and manage the GDAMS team to deliver the required engineering products in accordance with IPT SEDS and the resources identified in the IPT TOC.

3.2 The D level IPT leads shall present a summary cost and/or schedule variance explanation to the C level during the last week of each month.

3.3 Any schedule slip impacting an external link to the C4I & Vetronic SEDS must be identified and discussed immediately.

4.0 Problem Resolution

4.1 When a consensus cannot be reached, **the D level shall decide the course of action.** The decision shall be documented in the meeting minutes and it shall be noted that a consensus was not obtained. The D lead shall then brief the C level on the decision and the issues surrounding the decision for confirmation or reconsideration at the C level.

4.2 Any issue which resolution is outside the D level IPT's scope, funding (TOC) or schedules (SEDS) shall be elevated to the C level for consideration. The C level may 1) consider reallocation of contract funds, 2) pursue a remedy at the A/B level or 3) redirect the issue to be dealt with within the funds and schedule available.

SOURCE: AAAV PMO

APPENDIX D. MEANS AND STANDARD DEVIATIONS (SD) FOR IPT ROLES, EXPERIENCE, AND LEVELS A/B & C/D

Task Management Function

FUNCTIONS	IPT-ROLE		IPT-EXPERIENCE		IPT-LEVEL	
	Leader	Member	Yes	No	A/B	C/D
Task Management	**Mean (SD)**	**Mean (SD)**	**Mean (SD)**	**Mean (SD)**	**Mean (SD)**	**Mean (SD)**
Identifying potential problems	5.84 (.898)	5.68 (.933)	6.48 (.593)	6.57 (.502)	6.44 (.512)	6.57 (.547)
Establishing cohesiveness on project objectives	6.37 (.831)	6.15 (.670)	6.22 (.736)	6.23 (.731)	6.25 (.775)	6.21 (.717)
Coming up with innovative solutions to problems	6.10 (.875)	6.00 (1.03)	5.96 (1.11)	6.09 (.887)	5.94 (.680)	6.07 (1.07)
Finding solutions to problems						
Identifying needs for coordination	6.05 (.848)	6.03 (1.01)	5.87 (1.06)	6.14 (.879)	6.06 (1.06)	6.02 (.924)
Identifying project objectives	5.74 (1.15)	5.82 (.982)	5.83 (1.03)	5.76 (1.05)	6.06 (.854)	5.68 (1.08)
Using team perspectives to sort through options	5.89 (.875)	5.67 (.955)	5.65 (1.03)	5.80 (.868)	5.62 (.806)	5.79 (.976)
Establishing team cohesion on values	***6.05** (.911)	***5.42** (1.00)	5.64 (1.22)	5.63 (.877)	5.31 (1.08)	5.76 (.969)
Identifying areas of conflict	5.63 (1.12)	5.64 (.778)	5.48 (1.12)	5.74 (.701)	5.62 (.806)	5.64 (.932)
Process improvements	5.79 (.787)	5.57 (.987)	5.61 (1.03)	5.67 (.854)	5.80 (.941)	5.58 (.921)
Effectively managing and resolving conflict issues	5.58 (1.12)	5.51 (.997)	5.57 (.992)	5.51 (1.07)	5.56 (1.09)	5.52 (1.02)
Establishing decision criteria for problem solving	5.53 (1.02)	5.51 (.942)	5.43 (.992)	5.57 (.948)	5.56 (.814)	5.50 (1.02)
Consolidating plans	5.26 (1.24)	5.44 (1.16)	5.22 (1.28)	5.49 (1.12)	5.38 (.957)	5.38 (1.27)
Establishing measures of team performance	5.32 (.946)	5.10 (1.07)	5.09 (1.12)	5.23 (.973)	5.12 (1.02)	5.19 (1.04)
Assignment of individual work responsibilities	4.95 (1.13)	5.20 (1.10)	***4.74** (1.18)	***5.37** (1.00)	5.19 (.981)	5.10 (1.17)
Clarifying decision responsibility options	4.84 (1.42)	4.85 (1.41)	4.78 (1.65)	4.89 (1.23)	4.75 (1.34)	4.88 (1.44)
Balancing workload	4.63 (1.21)	4.62 (1.18)	4.65 (1.30)	4.60 (1.12)	4.81 (1.33)	4.55 (1.31)

* Represents ANOVA F probability < .10. Post hoc comparison of means using Least Significant Difference (LSD) test. Significant differences between means noted by highlighted (bold) figures.

Boundary Management Function

FUNCTIONS	IPT-ROLE		IPT-EXPERIENCE		IPT-LEVEL	
	Leader	Member	Yes	No	A/B	C/D
Boundary Management	**Mean (SD)**	**Mean (SD)**	**Mean (SD)**	**Mean (SD)**	**Mean (SD)**	**Mean (SD)**
Liaison with customer	6.37 (1.12)	6.34 (.847)	6.22 (1.09)	6.44 (.824)	6.56 (.814)	6.27 (.975)
Coordinating work with others on team	6.47 (.697)	6.31 (.731)	4.74 (1.18)	5.37 (1.00)	5.19 (.981)	5.10 (1.17)
Achieving management approval of changes to program work plan (how to achieve objectives)	5.84 (.898)	5.68 (.933)	5.91 (.921)	5.63 (.910)	5.69 (1.01)	5.76 (.888)
Achieving management approval of project Objectives	5.95 (.911)	5.74 (.978)	5.95 (.785)	5.71 (1.04)	5.88 (.806)	5.78 (1.01)
Liaison with other IPTs						
Liaison with individual contributors outside team	5.74 (1.05)	5.79 (1.19)	5.82 (1.14)	5.74 (1.15)	5.62 (1.46)	5.83 (.998)
Involving all pertinent perspectives in decisions	5.95 (1.08)	5.74 (.910)	5.87 (.815)	5.77 (1.06)	5.75 (1.00)	5.83 (.961)
Generating multiple options and scenarios	5.84 (.898)	5.62 (1.04)	5.52 (1.04)	5.80 (.964)	5.75 (.931)	5.67 (1.02)
Achieving management approval of project workplan	5.74 (.933)	5.50 (1.06)	5.64 (1.22)	5.54 (.886)	5.63 (1.02)	5.56 (1.03)
Liaison with upper management	5.68 (1.20)	5.62 (1.09)	5.87 (.920)	5.49 (1.22)	5.44 (1.37)	5.71 (1.02)
Translating ideas/concepts into action plans	5.32 (1.11)	5.41 (1.23)	5.22 (1.31)	5.49 (1.10)	5.62 (.885)	5.29 (1.27)
Liaison with supplier	5.58 (1.17)	5.08 (1.24)	5.52 (1.12)	5.06 (1.28)	5.44 (1.09)	5.17 (1.29)
Comparing data from multiple sources	5.10 (1.20)	5.21 (.991)	5.00 (1.11)	5.29 (1.02)	5.19 (.981)	5.17 (1.09)

* Represents ANOVA F probability < .10. Post hoc comparison of means using Least Significant Difference (LSD) test. Significant differences between means noted by highlighted (bold) figures.

Team Leadership, Performance Management, and Management Team Outputs and Dynamics Functions

FUNCTIONS	IPT- ROLE Leader	Member	IPT- EXPERIENCE Yes	No	IPT- LEVEL A/B	C/D
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Team Leadership						
Developing skills in team process / team dynamics	5.94 (.848)	5.64 (.843)	5.52 (.790)	5.89 (.867)	5.75 (.931)	5.74 (.828)
Enforcing technical standards	5.58 (1.21)	5.26 (1.03)	5.32 (1.09)	5.40 (1.06)	***4.94** (.929)	***5.53** (1.05)
Opportunities for mentoring	5.21 (1.18)	4.97 (1.08)	4.77 (5.23)	5.23 (1.17)	4.94 (1.18)	5.10 (1.09)
Developing and staying up-to-date on functional skills	4.95 (1.22)	4.97 (1.00)	4.78 (1.09)	5.09 (1.06)	4.69 (1.08)	5.07 (1.06)
Career opportunities	4.47 (1.26)	4.33 (.955)	4.17 (.984)	4.51 (1.10)	4.06 (.929)	4.50 (1.09)
Performance Management						
Reviewing team performance	5.84 (.898)	5.74 (.828)	5.64 (.848)	5.86 (.845)	***5.44** (.814)	***5.90** (.831)
Developing team goals	5.89 (.875)	5.64 (.843)	5.65 (.714)	5.77 (.942)	5.44 (.892)	5.83 (8.24)
Developing individual goals	4.84 (1.07)	4.56 (.852)	4.48 (1.04)	4.77 (.843)	4.50 (.966)	4.71 (.918)
Accuracy of performance appraisals	4.42 (1.12)	4.39 (.916)	***4.09** (.868)	***4.60** (1.01)	4.25 (.856)	4.46 (1.03)
Handling disciplinary problems	4.37 (1.16)	4.24 (.786)	4.18 (.853)	4.34 (.968)	4.38 (1.09)	4.24 (.860)
Management Team Outputs and Dynamics						
Reduced project cycle time	6.16 (1.07)	5.95 (.944)	***6.30** (.876)	***5.83** (1.01)	6.06 (1.06)	6.00 (.963)
Improved negotiation of design trade-offs	6.11 (.809)	5.79 (1.17)	6.00 (.816)	5.83 (1.20)	6.13 (.915)	5.81 (1.11)
Improved efficiency of resource use	6.32 (.749)	5.54 (1.32)	5.78 (1.08)	5.80 (1.30)	5.81 (1.22)	5.79 (1.22)
Increased amount of time in meetings that are not value added	4.00 (1.25)	4.26 (1.39)	3.57 (1.72)	4.11 (1.47)	3.73 (1.67)	3.98 (1.56)
Increased time-wasting conflicts	3.63 (1.54)	4.05 (1.60)	3.95 (1.21)	4.31 (1.41)	4.07 (1.49)	4.21 (1.30)

* Represents ANOVA F probability < .10. Post hoc comparison of means using Least Significant Difference (LSD) test. Significant differences between means noted by highlighted (bold) figures.

SOURCE: Developed by Author

APPENDIX E. TOTAL MEANS AND STANDARD DEVIATIONS (SD) FOR THE AAAV ORGANIZATION, USMC, GOVERNMENT CIVILIAN AND GDAMS

FUNCTIONS Task Management	AAAVORG. N=(58) Mean (SD)	USMC N=(10) Mean (SD)	GOV'T CIVILIAN N=(30) Mean (SD)	GDAMS N=(18) Mean (SD)
Identifying potential problems	6.56 (.536)	6.80 (.422)	6.39 (.502)	6.59 (.422)
Establishing cohesiveness on project objectives	6.22 (.738)	6.40 (.516)	6.28 (.574)	6.11 (.892)
Finding solutions to problems	6.10 (.809)	6.20 (.422)	6.06 (.938)	6.11 (.847)
Identifying needs for coordination	6.09 (.928)	***6.70** (.483)	6.00 (.767)	***5.93** (1.07)
Coming up with innovative solutions to problems	6.05 (.989)	6.30 (.823)	6.06 (.802)	5.96 (1.16)
Identifying project objectives	5.78 (1.06)	5.89 (1.05)	***6.06** (.802)	***5.56** (1.19)
Using team perspectives to sort through options	5.76 (.942)	***6.20** (.632)	***5.39** (.698)	5.85 (1.10)
Establishing team cohesion on values	5.68 (1.01)	6.20 (.632)	5.61 (.978)	5.54 (1.10)
Identifying areas of conflict	5.67 (.904)	5.80 (.789)	5.78 (.732)	5.56 (1.05)
Process improvements	5.66 (.919)	5.80 (.632)	5.67 (.908)	5.60 (1.04)
Effectively managing and resolving conflict issues	5.58 (.994)	5.60 (1.08)	5.39 (1.04)	5.70 (.953)
Establishing decision criteria for problem solving	5.54 (.978)	5.80 (.789)	5.67 (.908)	5.37 (1.08)
Consolidating plans	5.38 (1.21)	5.90 (1.20)	5.00 (1.24)	5.44 (1.15)
Establishing measures of team performance	5.20 (1.04)	***5.90** (.738)	***4.83** (.924)	5.18 (1.11)
Assignment of individual work responsibilities	5.11 (1.13)	***5.70** (.675)	***4.67** (.970)	5.18 (1.27)
Clarifying decision responsibility options	4.84 (1.42)	5.50 (.972)	4.67 (1.68)	4.70 (1.35)
Balancing workload	4.65 (1.19)	5.30 (.823)	4.50 (1.20)	4.52 (1.31)

1. Includes Subcontractors.
2. Includes Contractor (MITRE & TMA) personnel who do Government work functions.
* Represents ANOVA F-probability < .10. Post hoc comparison of means using Least Significant Difference (LSD) test. Significant differences between means noted by highlighted (bold) figures.

FUNCTIONS Boundary Management	AAAV ORG. N= (58)	USMC N= (10)	GOV'T CIVILIAN N= (30)	GDAMS N= (18)
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Liaison with customer	6.39 (.919)	6.40 (.699)	***6.83** (.384)	***6.07** (1.13)
Coordinating work with others on team	6.38 (.707)	6.60 (.516)	6.22 (.808)	6.41 (.694)
Liaison with other IPTs	5.95 (1.04)	6.10 (.568)	5.89 (1.08)	5.93 (1.17)
Involving all pertinent perspectives in decisions	5.84 (.977)	5.90 (1.20)	5.61 (1.04)	5.96 (.854)
Achieving management approval of changes to program work plan (how to achieve objectives)	5.81 (.870)	***6.30** (.675)	***5.50** (.870)	5.85 (.881)
Achieving management approval of project objectives	5.81 (.973)	***6.50** (.707)	***5.50** (1.10)	5.77 (.863)
Liaison with individual contributors outside team	5.74 (1.15)	6.00 (.667)	5.89 (1.08)	5.54 (1.33)
Generating multiple options and scenarios	5.72 (1.01)	6.10 (.738)	5.73 (1.01)	5.67 (1.11)
Achieving management approval of project workplan	5.65 (.994)	***6.00** (.943)	***5.22** (1.17)	5.81 (.801)
Liaison with upper management	5.67 (1.12)	5.90 (1.20)	5.44 (1.04)	5.74 (1.16)
Translating ideas/concepts into action plans	5.40 (1.21)	5.70 (1.42)	5.00 (1.08)	5.56 (1.19)
Liaison with supplier	5.27 (1.25)	5.30 (1.06)	5.06 (1.43)	5.41 (1.22)
Comparing data from multiple sources	5.20 (1.07)	5.30 (.945)	5.17 (.985)	5.19 (1.20)

1. Includes Subcontractors.
2. Includes Contractor (MITRE & TMA) personnel who do Government work functions.

* Represents ANOVA F probability < .10. Post hoc comparison of means using Least Significant Difference (LSD) test. Significant differences between means noted by highlighted (bold) figures.

FUNCTIONS	AAAV ORG.	USMC	GOV'T CIVILIAN	GDAMS
Team Leadership	N= (58)	N= (10)	N= (30)	N= (18)
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Developing skills in team process / team dynamics	5.78 (.832)	***6.20** (.632)	***5.50** (.858)	5.81 (.834)
Enforcing technical standards	5.43 (1.06)	***6.10** (.738)	***5.00** (.970)	5.46 (1.10)
Opportunities for mentoring	5.07 (1.13)	5.40 (1.17)	4.89 (1.02)	5.08 (1.20)
Developing and staying up-to-date on functional skills	4.96 (1.08)	***5.67** (1.22)	***4.56** (.784)	5.00 (1.11)
Career opportunities	4.40 (1.08)	4.30 (.483)	4.33 (1.08)	4.48 (1.25)
Performance Management				
Reviewing team performance	5.83 (.818)	6.10 (.738)	5.78 (.732)	5.77 (.908)
Developing team goals	5.78 (.832)	6.20 (.632)	5.56 (.705)	5.78 (.934)
Developing individual goals	4.71 (.916)	4.90 (.994)	4.56 (.616)	4.74 (1.06)
Accuracy of performance appraisals	4.44 (.984)	***5.00** (1.05)	***4.22** (.548)	4.38 (1.13)
Handling disciplinary problems	4.30 (.944)	4.00 (.471)	4.44 (1.04)	4.31 (1.01)
Management Team Outputs and Dynamics				
Reduced project cycle time	6.05 (.970)	5.70 (1.06)	6.00 (1.03)	6.22 (.892)
Improved negotiation of design trade-offs	5.95 (1.04)	6.30 (.675)	5.72 (1.27)	5.96 (.980)
Improved efficiency of resource use	5.84 (1.21)	6.30 (.675)	5.50 (1.62)	5.89 (1.01)
Increased time-wasting conflicts	4.22 (1.36)	4.50 (1.51)	4.06 (1.21)	4.23 (1.42)
Increased amount of time in meetings that are not value added	3.96 (1.59)	4.40 (1.43)	4.00 (1.41)	3.76 (1.79)

1. Includes Subcontractors.
2. Includes Contractor (MITRE & TMA) personnel who do Government work functions.
* Represents ANOVA F probability < .10. Post hoc comparison of means using Least Significant Difference (LSD) test. Significant differences between means noted by highlighted (bold) figures.

SOURCE: Developed by Author

APPENDIX F. EMPLOYEE RECOMMENDATIONS

The following recommendations were taken collectively from the feedback of employees that participated in this case study. These recommendations may expand the benefits of collocation on AAAV program performance.

- In-depth training must be continuous and clearly articulate how incentives relate to process/team performance.
- Continue to educate Government personnel on their roles as program office representatives. Government needs to understand that prime contractor has the responsibility for performing to the contract. There are times when they need to let the contractor make a decision and proceed on.
- Ensure IPTs identify all impacted personnel as part of their core team, including the "ilities," and technical representatives from other IPTs.
- Send IPT leads to the same formal leadership/management training. An IPT is only as good as the IPT lead allows it to be.
- Continue to focus on improving the flow of information across the IPTs.
- Work to develop standard processes for IPTs to use on a day-to-day basis.
- Make sure to improve the connection to the non-collocated structure. Many vendors/sub-contractors to GDAMS are off-site which can create significant communication difficulties and delays.
- Thoroughly define and monitor the rules of customer direction into IPT's to prevent an "out of scope" situation.
- Early on in the contract, the contractor should educate the customer about the pitfalls in a new weapon system design contract. Things do not always go smoothly and setbacks are to be expected.
- Government civilians and Marines contribute to the team. As it is now they advise but do not do much work in developing the design. Make them be part of the work team and not just be present at weekly meetings.

- Increase training with a focus in group decision-making. Also provide additional training for IPTs on Trade Studies.
- Need a very active issue resolution procedure that allows for continued progress and team satisfaction. Training that focus on consensus building and expectations (sometimes not favorable from one individual perspective) is a must.
- There needs to be consistency between how various government counterparts interact w/their IPTs (some are strong team members, some are still "we vs. them"
- Set up days or blocks of time when no meetings may be held.
- Detail in writing empowerment abilities of the "D" level IPT leads. What exactly can/cannot they do?

SOURCE: AAAV Organization

LIST OF REFERENCES

A Formula For Action, Report to the President on Defense Acquisition, The President's Blue Ribbon Commission on Defense Management, April 1996.

Allen, T.J., "Organizational Structure, Information Technology, and R&D Productivity," *IEEE Transactions on Engineering Management*, pp. 212-217, November 1986.

Allen, T.J., *Managing the Flow of Technology,* MIT Press, Cambridge, MA, 1977.

Andrews, Katherine Z, "Cross Functional Teams: Are They Always the Right Move?" *Harvard Business Review*, Vol. 73, No. 6, p. 12 (2), November-December 1995.

Authority for the Federal Aviation Administration Acquisition Management System: Appendix B-Decision Maker Roles and Responsibilities, Federal Aviation Administration, 1 April 1996.

Crow, K.A., *Enabling Product Development Teams With Collocation,* DRM Associates, Palos Verdes, CA, 1995.

DiTrapani, Anthony R., and Geither, Jonathan D., *Getting the Most Out of Integrated Product Teams (IPTs),* Center for Naval Analyses, Alexandria, VA, May 1996.

DOD Guide to Integrated Product and Process Development, (Version 1.0), Department of Defense, 5 February 1996.

DOD Regulation 5000.1, 5000.2-R, Office of the Under Secretary of Defense for Acquisition Reform, Washington, DC, 1996.

Dumaine, Brian, "The Trouble With Teams," *Fortune*, Vol. 130, No. 5, p. 86(5), September 5, 1994.

Electronic Industries Association (EIA) Standard IS-632, U.S. Army Management Engineering College, Arlington, VA 22201, pp. 1-67.

Feigley, James, Colonel, U.S. Marine Corps, Direct Reporting Program Manager Advanced Amphibious Assault Vehicle, Seminar on 5 September 1996.

Feigley, James, Colonel, U.S. Marine Corps, Direct Reporting Program Manager Advanced Amphibious Assault Vehicle, Seminar on 20 November 1997.

Frohman, Mark A., "Do Teams...But Do Them Right," *Industry Week*, Vol. 244, No. 7, p. 21(3), April 3, 1995.

Hull, Frank M., Collins, Paul D., "Composite Forms of Organization as a Strategy for Concurrent Engineering Effectiveness," *IEEE Transactions on Engineering Management*, pp. 133-141, May 2, 1996.

Integrated Product and Process Development (IPPD) and Integrated Product Team (IPT), U.S. Navy Acquisiton Reform, http://www.acq-ref.navy.mil., October 1997.

Jordan, Debra J., "Managing Conflict in Teams and Examining Hiring Assumptions," *Camping Magazine*, Vol. 69, No. 1, p. 17(2), September-October 1996.

Khuri, Paul F., Howard M. Pleuyak Jr., *An Investigation of Integrated Product Development-Implementation Issues: A Case Study of Bosma Machine and Tool Corporation*, MS Thesis. AFIT/GSM/LAS/93S-11. School of Systems and Logistics, Air Force Institute of Technology, Wright-Patterson AFB OH, (AD-A273917), Winter 1993.

Lake, Jerome G., "Concurrent Engineering: A New Initiative-Can It Solve DOD Acquisition Problems?" *Program Manager*, pp 18-25, September-October 1991.

Lopez, Stephanie., *An Investigation of Integrated Product Development: A Case Study of An F-22 Prime Contractor*, MS Thesis. AFIT/GLM/LAR/94S-18. School of Logistics and Acquisition Management, Air Force Institute of Technology, Wright-Patterson AFB OH, September 1994.

Ludwick, Paul, "Teams By Design: Hiring For Synergy," *Public Management*, Vol. 77, No. 9, p. 9(5), September 1995.

McGarvey, Robert, "Joining Forces: 12 Steps To Creating Winning Teams," *Entrepreneur*, Vol. 24, No. 9, p. 80(3), September 1996.

Measuring Team Success: Benchmark, Donna Fenn, Inc., Vol. 17, No. 16 p. 94(1), November 1995.

Meister, David P. L., *Integrated Product Team Implementation and Leadership at the Program Level,* Master's Thesis, School of Systems Management, Naval Postgraduate School, Monterey, CA, December, 1996.

Memo for Distribution of the Military Departments, etal. Subject: "Policy for Collocation of Department of the Navy Program Management Teams, " Assistant Secretary of the Navy, Research Development and Acquisition, 1 October 1996.

Memo for Secretaries of the Military Departments, et al. Subject: Use of Integrated Product and Process Development Teams in DOD Acquisition, Secretary of Defense, 10 May 1995.

Memorandum of Agreement: "Roles and Responsibilities of the DRPM AAAV Program Office and DCMC Baltimore, MD, -Manassas in support of the AAAV effort," between James M. Feigley, Col. USMC, DRPM AAAV and J. Craig Walsh, Jr., Col. USA, Commander, DCMC Baltimore, MD, dated 26 August 1997.

Meyer, Christopher, "How The Right Measures Help Teams Excel," *Harvard Business Review*, Vol. 72, No. 3, p. 95(9), May-June 1994.

Mohrman, S. A., Cohen, S. G., and Mohrman, A. M. Jr., *Designing Team Based Organizations*, Jossey-Bass Publishers, San Francisco, CA, 1995.

Moore, Keith M., *Contract Administration Organization: A Case Study of the U.S. Marine Corps Advanced Amphibious Assault Vehicle Program,* Master's Thesis, School of Systems Management, Naval Postgraduate School, Monterey, CA, December 1996.

Rafii, F., "How Important Is Physical Collocation to Product Development Success?" *Business Horizons*, pp. 78-84, January-February 1995.

Rules of The Road, A Guide For Leading Successful Integrated Product Teams, Office of the Under Secretary of Defense for Acquisition and Technology, Assistant Secretary of Defense for Command, Control, Communications, and Intelligence (C3I), 1995.

Sebastian, Pamela, "Good Teamwork Merits A Team Bonus, Right? Not Necessarily," *The Wall Street Journal*, February 6, 1997, PA1(W), PA1(E), col 5 (3 col in).

Shapiro, B.P., "Functional Integration: Getting All the Troops to Work Together," *Managing People and Organizations*, Harvard Business School, Boston, 1992.

Smith, Robert P., "The Historical Roots of Concurrent Engineering Fundamentals," *IEEE Transactions on Engineering Management*, pp. 67-78, February 1997.

"The Paradoxes of Teamwork," *USA Today*, Vol. 124, No. 2611, p. 7(1), April 1994.

"Too Much Team Harmony Can Signal Trouble," *Nation's Business*, Vol. 84, No. 4, p. 10(1), April 1996.

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